*Transactions and Proceedings of the Botanical Society of Edinburgh*

Botanical Society of Edinburgh

# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH

# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

VOLUME XXII.

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(1901–1904).

*WITH NUMEROUS ILLUSTRATIONS.*

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# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

## SESSION LXV.

MEETING OF THE SOCIETY, Thursday, November 8, 1900.

The Rev. DAVID PAUL, M.A., LL.D., President, in the Chair.

The following Officers of the Society were elected for the Session 1900–1901 :—

### PRESIDENT.

Rev. DAVID PAUL, M.A., LL.D.

### VICE-PRESIDENTS.

Colonel FRED. BAILEY, R.E.
WILLIAM BONNAR.
ARTHUR E. DAVIS, Ph.D., F.L.S.
SYMINGTON GRIEVE.

### COUNCILLORS.

W. CALDWELL CRAWFORD.
Professor G. F. SCOTT-ELLIOT, M.A., B.Sc., F.L.S.
Professor COSSAR EWART, M.D., F.R.SS. L. & E.
ROBERT LINDSAY.
R. STEWART MACDOUGALL, M.A., D.Sc.
A. ROBERTSON, M.A., B.Sc.
ALEXANDER SOMERVILLE, B.Sc., F.L.S.
Professor J. W. H. TRAIL, M.A., M.D., F.L.S.
ROBERT TURNBULL, B.Sc.
WILLIAM WATSON, M.D.

*Honorary Secretary*—WILLIAM CRAIG, M.D., F.R.S.E., F.R.C.S.Ed.
*Foreign Secretary*—ANDREW P. AITKEN, M.A., D.Sc., F.R.S.E.
*Treasurer*—RICHARD BROWN, C.A.
*Assistant Secretary*—JAMES ADAM TERRAS, B.Sc.
*Artist*—FRANCIS M. CAIRD, M.B., C.M., F.R.C.S.Ed.
*Auditor*—ROBERT C. MILLAR, C.A.

## LOCAL SECRETARIES.

*Aberdeen*—Professor J. W. H. TRAIL, M.A., M.D., F.L.S.

*Bathgate*—ROBERT KIRK, M.D., F.R.C.S.Ed.

*Beckenham, Kent*—A. D. WEBSTER.

*Berwick-on-Tweed*—FRANCIS M. NORMAN, R.N.

*Birmingham*—GEORGE A. PANTON, F.R.S.E., 73 Westfield Road.

,, W. H. WILKINSON, F.L.S., F.R.M.S., Manor Hill, Sutton Coldfield.

*Bournemouth*—JOHN ARCHIBALD, M.D., F.R.S.E.

*Bromley, Kent*—D. T. PLAYFAIR, M.B., C.M.

*Calcutta*—DAVID PRAIN, M.B., F.R.S.E., F.L.S., Royal Botanic Garden.

,, Professor S. C. MAHALANOBIS, B.Sc.. F.R.S.E., F.R.M.S., Presidency College.

*Cambridge*—ARTHUR EVANS, M.A.

*Chirnside*—CHARLES STUART, M.D.

*Croydon*—A. BENNETT, F.L.S.

*Dundee*—Professor P. GEDDES, F.R.S.E.

*East Liss, Hants.*—JAMES SYKES GAMBLE, M.A.

*Glasgow*—Professor F. O. BOWER, Sc.D., F.R.S., F.L.S.

,, Professor J. CLELAND, M.D., F.R.S.

,, Professor SCOTT-ELLIOT, F.L.S.

*Kilbarchan*—Rev. G. ALISON.

*Lincoln*—GEORGE MAY LOWE, M.D., C.M.

*London*—WILLIAM CARRUTHERS, F.R.S., F.L.S.

,, E. M. HOLMES, F.L.S., F.R.H.S.

,, Sir GEORGE KING, M.D., F.R.S.

*Melrose*—W. B. BOYD, of Faldonside.

*Otago, New Zealand*—Professor JAMES GOW BLACK, D.Sc., University.

*Perth*—Sir ROBERT PULLAR, F.R.S.E.

*Philadelphia, U.S.A.*—Professor JOHN M. MACFARLANE, D.Sc., F.R.S.E.

*Saharumpore, India*—J. F. DUTHIE, B.A., F.L.S.

*St. Andrews*—Professor M'INTOSH, M.D., LL.D., F.R.SS. L. & E.

,, ROBERT A. ROBERTSON, M.A., B.Sc.

,, Dr. J. H. WILSON.

*Toronto, Ontario*—W. R. RIDDELL, B.Sc., B.A.

,, ,, Professor RAMSEY WRIGHT, M.A., B.Sc.

*Wellington, New Zealand*—Sir JAMES HECTOR, M.D., K.C.M.G., F.R.SS. L. & E.

*Wolverhampton*—JOHN FRASER, M.A., M.D.

W. J. CULLEN, Esq., 10 Darnaway Street, was proposed as a Resident Fellow of the Society by Mr. ALEXANDER SOMERVILLE, B.Sc., F.L.S., and seconded by the Rev. D. PAUL, M.A., LL.D.

Professor BAYLEY BALFOUR read a paper on "The Scottish Chenopodiaceæ."

Dr. D. FRASER HARRIS exhibited Grain from the Roman Granary in the Camp at Castlecary.

Mr. A. W. BORTHWICK, B.Sc., showed a specimen of *Quercus ilex* struck by lightning, and gave a review of the Effects of Lightning on Trees in general.

Dr. J. M. DALZIEL exhibited three new Chinese Plants.

Mr. GEORGE WEST gave a demonstration of Microscopic Sections of Rock with Vegetable Remains.

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MEETING OF THE SOCIETY, December 11, 1902.

Dr. ARTHUR DAVIES in the Chair.

The TREASURER submitted the following Statement of Accounts for the Session 1901–1902:—

INCOME.

| | £ | s. | d. |
|---|---|---|---|
| Annual Subscriptions, 1901–1902; 63 at 15s. | £47 | 5 | 0 |
| Do. 1900–1901; 1 at 15s. | 0 | 15 | 0 |
| Composition for Life Membership | 2 | 2 | 0 |
| *Transactions*, etc., sold | 1 | 10 | 0 |
| Subscriptions to Illustration Fund | 4 | 11 | 0 |
| Interest on Deposits in Bank | 2 | 6 | 6 |
| | £58 | 9 | 6 |

J. R. Davidson, Esq., 17 Lutton Place, was proposed as a Resident Fellow of the Society by Mr. W. W. Smith, M.A., and seconded by Dr. R. Stewart MacDougall.

The Honorary Assistant-Secretary read two communications from Dr. Alexander Morrison, viz. "A new West-Australian Plant, *Drosera bulbigena*, A. Morrison" (p. 417); and "Note on the Formation of the Bulb in Drosera" (p. 419), communicated by Professor Bayley Balfour.

Mr. A. W. Borthwick exhibited specimens illustrating Fungus attacks on Trees.

Mr. William Young showed a fine example of the Bird's-nest Fungus.

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Meeting of the Society, December 10, 1903.

Robert Lindsay, Esq., in the Chair.

J. R. Davidson, Esq., 17 Lutton Place, proposed by Mr. W. W. Smith, M.A., and seconded by Dr. R. Stewart MacDougall, was balloted for as a Resident Fellow, and duly elected.

M'Taggart Cowan, Esq., Jun., 33 Drummond Place, was proposed as a Resident Fellow by Mr. A. W. Borthwick, B.Sc., and seconded by Mr. W. W. Smith, M.A.

Mr. Alexander Somerville read a communication from Mr. James White, F.L.S., President of the British and District Pharmaceutical Association, "On a Botanical Visit to the Balearic Islands in April 1903," and exhibited specimens in illustration (p. 436).

The Honorary Assistant-Secretary showed several specimens of Young Spruce killed by attack of Crane-Fly Maggots.

## MEETING OF THE SOCIETY, January 14, 1904.

ROBERT LINDSAY, Esq., in the Chair.

M'TAGGART COWAN, Esq., Jun., 33 Drummond Place, proposed by Mr. A. W. BORTHWICK, B.Sc., and seconded by Mr. W. W. SMITH, M.A., was balloted for as a Resident Fellow, and duly elected.

Mr. WILLIAM EVANS read a communication on "The Hepaticæ of the Edinburgh District."

Mr. A. W. BORTHWICK read Mr. T. A. Sprague's "Preliminary Report on the Botany of Captain Dowding's Colombian Expedition, 1898–1899" (p. 425).

Mr. H. F. TAGG exhibited Museum preparations of *Cuscuta* Seedlings, and Flowering Branches of *Cuscuta reflexa*.

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## MEETING OF THE SOCIETY, February 11, 1904.

Professor J. W. H. TRAILL, M.D., F.R.S., President, in the Chair.

Mrs. MAXWELL, Bangholm Bower, Goldenacre, recommended by the COUNCIL as a Lady Member, was duly elected.

Mr. WILLIAM EVANS read a communication by himself and Mr. W. EDGAR EVANS on "A Contribution towards an Alien Flora of the Edinburgh District," and exhibited specimens.

Mr. ALEXANDER COWAN read his "Report on the Scottish Alpine Club Botanical Excursion in 1903" (p. 448).

Mr. W. CALDWELL CRAWFORD exhibited specimens of Potatoes grown in Soils Unsterilised and Sterilised.

Mr. A. D. RICHARDSON brought forward some Twigs of *Fraxinus excelsior*, showing abnormal Phyllotaxis.

## Meeting of the Society, March 12, 1904.

R. A. Robertson, Esq., M.A., B.Sc., in the Chair.

J. C. Pottage, Esq., 8 Corennie Gardens, was proposed as a Resident Fellow by Mr. Duncan M'Glashan, and seconded by Dr. R. Stewart MacDougall.

James Finlayson, Esq., 8 Thirlestane Road, was proposed as a Resident Fellow by Dr. R. Stewart MacDougall, and seconded by Dr. William Craig.

Mr. R. A. Robertson, gave his communication on "Variations in *Lycopodium clavatum*, L.," and illustrated it with lantern slides.

Mr. James A. Terras read a paper on "Negative Variation in expanding Tulip."

Mr. J. Rutherford Hill gave an exhibition of Chinese, South American, and French Orange Oils, and their Constituents.

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## Meeting of the Society, April 14, 1904.

Robert Lindsay, Esq., in the Chair.

The following Candidates were balloted for, and duly elected Resident Fellows of the Society:—

J. C. Pottage, Esq., 8 Corennie Gardens, proposed by Mr. Duncan M'Glashan, and seconded by Dr. R. Stewart MacDougall.

James Finlayson, Esq., 8 Thirlestane Road, proposed by Dr. R. Stewart MacDougall, and seconded by Dr. William Craig.

The Honorary Assistant-Secretary communicated, on behalf of the Rev. Albert B. Weymouth, M.A., a paper on "The Trees of the Hawaiian Islands."

Mr. James A. Terras read his communication on "Notes regarding the Origin of Lenticels" (p. 450).

Mr. JAMES WHYTOCK exhibited Flowering Plants from the Palace Gardens, Dalkeith.

Mr. A. W. BORTHWICK showed some Preparations of several Forest Trees in the various conditions of Flower and Fruit.

MEETING OF THE SOCIETY, May 12, 1904.

W. CALDWELL CRAWFORD, Esq., in the Chair.

The HONORARY ASSISTANT-SECRETARY exhibited specimens illustrating Cocoa and its Manufactured Products, and gave a short account of the growth of the plant.

Mr. POTTS exhibited some specimens of Saxifrages grown by himself, and of some natural crosses.

MEETING OF THE SOCIETY, June 9, 1904.

W. CALDWELL CRAWFORD, Esq., in the Chair.

Mr. A. W. BORTHWICK exhibited a number of abnormal Cones of *Picea nigra*.

Mr. W. W. SMITH exhibited *Polygala austriaca*, Krantz.

MEETING OF THE SOCIETY, July 14, 1904.

W. CALDWELL CRAWFORD, Esq., in the Chair.

Mr. J. RUTHERFORD HILL exhibited the Fruit of *Solanum Melongena* (the Egg Plant).

On behalf of Mr. W. Malcolm Miller, the HONORARY ASSISTANT-SECRETARY showed specimens of Potato Seedlings exhibiting variation in behaviour as regards tuber production.

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PART I.

EDINBURGH:
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TRANSACTIONS AND PROCEEDINGS

OF THE

BOTANICAL SOCIETY OF EDINBURGH.

SESSION LXV.

## Presidential Address.—On the Ferns, especially the Filmy Ferns, of Jamaica. By Rev. David Paul, LL.D., Edinburgh.

(Delivered 8th November 1900.)

There are few botanical subjects on which I should feel any confidence in addressing a society like this. But, as you have done me the honour to call me to the chair—an honour which I greatly appreciate, and for which I sincerely thank you,—the least I can do is to take advantage of the opportunity offered me to-night, and read you a paper dealing with some corner of the great field of botanical science. After reviewing one or two of these corners into which I have chanced to stray, I have come to the conclusion that I could not, perhaps, do better than offer to you some remarks on the Ferns of Jamaica, partly because the subject seems interesting in itself, and partly because it possesses something of novelty, as almost none of us have had the privilege of exploring the flora of that beautiful island, one of the fairest and richest in vegetation in the great British Empire. With the exception, perhaps, of the island of Ceylon, there is no part of Her Majesty's dominions that so teems with plant life in varied and remarkable forms, and, with the exception perhaps of

New Zealand, there is no part of it which displays such an extraordinary wealth of fern life. It would be impossible to deal in a paper like this with the whole subject of the Ferns of Jamaica—the number of species, and even of genera, being so great, as we shall presently see. It will be better to confine its limits mainly to the fascinating group of Filmy Ferns represented by the genera *Hymenophyllum* and *Trichomanes*, merely adding some observations on one or two of the more remarkable forms that occur outside of these genera.

It will be necessary, first, to say something in regard to the physical features of the island itself, by way of explanation of the fact that ferns of all kinds find there a home so well adapted to their nature and requirements.

Jamaica, then, is a hilly or, rather, mountainous island. There is very little level ground, even along the seacoast. Everywhere the land begins to rise almost at once, gradually ascending to the heights of the central chain of hills, which, in the Blue Mountains, attain an elevation of more than 7000 ft. There is thus great variety of temperature and climate. In the lowlands, the mean temperature is about 75° at night, and about 85° during the day, but the heat is tempered by both land and sea breezes. At Newcastle (3800 ft.), the mean temperature of the hottest month (July) is 68°, and of the coolest month (January) 61°. As you ascend still higher the mean temperature, of course, proportionately falls, till you gain the summit of the Blue Mountains, where frost has been occasionally, but rarely, registered. A large part of the surface of the island is therefore free from the excessive tropical heat under which the great majority of ferns cannot luxuriate. But ferns demand something else than moderately cool temperature, they must have both shade and moisture. Shade they receive in abundance from the bush or scrub—one can hardly call it forest—that clothes the hillsides, and is generally dense enough to screen them from the direct rays of the sun. There is no lack of moisture either. Streams everywhere run down from the upper regions to the sea, more than one hundred of them in all. Then from these streams, and from the ocean, the heat of the sun raises copious vapours, which

produce, as they ascend, clouds saturated with moisture, and these, coming into contact with the colder strata of air aloft, are condensed, and fall on the hills in frequent and heavy showers, sometimes in torrents. It will be well, as bearing closely on the subject in hand, to give some idea of what the rainfall is. I will take the year from April 1895 to March 1896, as being the year which covers my residence in the island. At Kingston, near the sea-level, the rainfall was 22·3 in.; at the Hope Botanic Garden, at an elevation of 600 ft., it was 50·98 in.; at the Castleton Botanic Garden, nearly the same altitude, it was 108·88 in.; at the Hill Gardens, which lie 4900 ft. above the sea, it was 122·45 in.; and on the Blue Mountain peak, at a height of 7423 ft., it was 176·86 in. And though some months are very much more rainy than others, there was no month in which the rainfall, at least on the higher grounds, was not considerable. It would seem then that Jamaica possesses all the requisites necessary for the luxuriant growth of such a plant as the fern—shade, moisture, and a temperature which varies at different elevations from heat to comparative coolness. A fitter home for this particular class of plants could not be conceived.

But, as a matter of fact, are ferns found there in such numbers and variety as to warrant us in regarding their abundance as something phenomenal? Let us institute a comparison between Jamaica and the British Isles. But observe, first of all, that the area of Jamaica is only about four thousand square miles, a little less, *i.e.*, than the area of Inverness-shire, including in the county the islands that form part of it. Now in the whole of the British Isles there are, according to the last edition of the London Catalogue, only 20 genera of ferns, containing 47 species, and of these genera, 11 have only 1 species apiece. In Jamaica, on the other hand, there are, according to the most recent authority, Mr. Jenman, of Demerara, no fewer than 45 genera, with 473 species—all within that small area, about equal in size to Inverness-shire—more than ten times as many as occur in the whole of Great Britain and Ireland. Many of the genera too are very rich in species. The genus *Cyathea* has 16 species, *Pteris*

has 20, *Hymenophyllum* has 23, *Trichomanes* has 25, *Adiantum* has 27, *Acrostichum* has 33, *Nephrodium* has 56, *Asplenium* has 58, and *Polypodium* has 79, *i.e.* the *Polypodia* alone are more than twice as many as all our species taken together. These are very remarkable facts, and they show how perfectly adapted Jamaica is to that particular form of vegetation. Indeed, when one is introduced for the first time to that fern paradise, one feels perfectly bewildered by the number of different forms that are met with on every side, and a residence in the island would require to be somewhat prolonged to enable one to make the acquaintance of even the commoner species. During a part of the time I spent there I had the advantage of having as a companion in fern-rambles a member of our Society, Mr. Neill Fraser, whose knowledge of fern botany is both accurate and extensive, and without whose aid I should not have been able to learn half as much as I did.

There is one class of ferns that has a special attraction for a botanist in Jamaica, and which he can never sufficiently admire for their great delicacy and beauty,—I mean those that go under the general name of Filmy Ferns, because of the film-like translucency of their structure. They belong to the genera *Hymenophyllum* and *Trichomanes.* From the three species which occur in this country one can form no idea of the grace and loveliness of the tropical forms, and dried specimens, however carefully they are dried, give but a poor conception of their appearance when seen in their natural habitats. Two of our British species occur in Jamaica, one of them, *Hymenophyllum Tunbridgense,* on decaying logs in forests at an altitude of 5000 to 7000 ft., and the other, *Trichomanes radicans,* common throughout the island on moist ground, from a low elevation to the highest slopes of the hills. *Hymenophyllum unilaterale,* Bory, is not a Jamaican or West Indian plant. There is nothing more interesting, when botanising in a foreign country, than to find a plant which is rare and much-prized here occurring day after day in many different localities, as we find *Woodsia ilvensis* in Norway, or *Lloydia serotina* in Switzerland, or *Trichomanes radicans* in Jamaica. There is another species of

*Trichomanes* in Jamaica, *T. rigidum*, Sw., which has very much the appearance of *T. radicans*, but is a much more wiry and stiff plant, growing on the ground in damp woods, and more luxuriant the higher you ascend. The rootstock does not creep as in *T. radicans*, but the plant rises in a tufted form; the fronds, however, are cut in the same fashion, and the dark green colour is characteristic of both. The great majority of the filmies are not to be met with at the low elevation at which *T. radicans* occurs, although there are a few that may be found fairly low. They occur in greatest profusion at a height of from 5000 to 6000 ft. Below that altitude you will find more species of *Trichomanes* than of *Hymenophyllum*, the latter, with the exception of *H. polyanthos* and one or two others, almost all growing at least above 4000 ft., whereas *T. punctatum*, *T. sphenoides*, *T. Krausii*, *T. sinuosum*, *T. Bancrofti*, *T. scandens*, *T. radicans*, and *T. rigidum* can all be found at comparatively low elevations, their range extending, however, in most cases far up the mountain sides. The happy hunting-ground for the filmies is then from 5000 ft. right up to the summits of the hills. And this creates a difficulty, for it is exceeding difficult to find any kind of accommodation at such a height. If it had not been for the hospitality of Mr. Fawcett, the Director of the Jamaica Public Gardens, Mr. Neill Fraser and I would have been unable to prosecute our researches. But Mr. Fawcett was at that time living at the Hill Garden, at an elevation of 5000 ft., quite close to slopes of hill forest which exactly suited our purpose, and, in addition to his kind reception of us into his house, he put his botanical knowledge and his herbarium at our disposal, so that we had the best opportunity of making the most of a short visit.

I remember, the first morning after we arrived, following a path that led gradually upwards towards Morse's Gap, and passing great tangled thickets of *Gleichenia*, seeing, also, what seemed a strange sight there, quantities of *Pteris aquilina*, the same as, and yet apparently slightly different from, our common brake. I remember noticing a gigantic tree-fern, *Cyathea pubescens*, Mett., I think, about forty feet high, the long, thin stem bending a little out of the perpendicular, and supporting a graceful plume of fronds

at the top. On the bank, on one side, a quantity of wild strawberries were showing their ripe fruit in the month of January. On the mossy root of a tree we were delighted to discover a number of tiny plants of *Xiphopteris serrulata*, or *Polypodium serrulatum* as it is also called, of which I have a specimen here, a curious little fern, which I afterwards found in great abundance on the Soufriére, in St. Vincent. There was something at every step to catch the eye, and to hinder our progress. But at last we got to the Gap, where the path led down to the other side of the mountain range, and then we plunged upwards into the wood in quest of the filmies, which we knew were there. The atmosphere among the trees was close and muggy. The soil under our feet and the tree-trunks around us were saturated with moisture—moisture which never dries up, for the damp vapours at that height are always wrapping the hills in their folds, and the direct rays of the sun cannot penetrate. In such a spot it is not to the ground, but to the trees, to the trunks and the branches, that you look for the filmies you have come to seek. For one growing on the ground there are a hundred on the trees. On the wet surface of the cracked and fissured bark the fern spores find an ideal place to germinate in. The stems of some of the tree-ferns, in particular, being clothed with aërial rootlets, or covered with a rough draffiness, form the very kind of home that the tender filmies love to dwell in. Let us look about us, then, and see what there is to reward us for coming all the way from Scotland into this strange, far-off, solitary place, where the whistle of the steam-engine has never been heard, and Nature reigns alone, as she has done from the creation of the world. Here, on this fern-stem, is a mass of dark-green *Trichomanes trichoideum*, Sw., surely the daintiest plant that grows, the delicate fronds rising from its thread-like, creeping rootstock, and cut into segments fine as hairs, bearing the diminutive fructification, which is yet perfect in all its parts—cup, sori, and protruding seta. To find this gem of a plant alone, in all the ideal grace of its fairy-like fronds, is recompense enough for the expenditure of much time and trouble. But there are other things quite as good in their way. Here, for instance, is *Hymenophyllum*

*asplenioides*, Sw., hanging down by its hair-like stem from the horizontal bough of a tree, with its narrow, tapering fronds, six or seven inches long, bright green and transparent, beautiful both in colour and in form. And here, too, growing in a similar position, is another very fine filmy of a peculiar brownish grey colour, forming a great mass of narrow, pendent fronds, eighteen inches or more in length, and covered all over with a woolly hairiness. It is *H. sericeum*, Sw., a fern that has a character of its own, and can be mistaken for no other. I believe it is very difficult to cultivate in this country, its dense woolliness rendering it very liable to damp off. Among filmies of this elegant, tapering, pendent type of frond may be mentioned here *Trichomanes sinuosum*, Rich., though it does not grow at this altitude, and does not seem to be very common in Jamaica at all. I found it in fine form near the Grand Etang, in Grenada. In my specimens, the frond, exclusive of the short stem, reaches to ten inches. It has something of the look of *Hymenophyllum asplenioides*, but the lobes are much sharper. It is very thin in the texture, and of a fine pale green colour. It is partial to the trunks of tree-ferns, and seems, as Mr. Jenman notes, to prefer *Cyathea elegans*, Hew., which has a stem covered with prickles and fibres, affording the creeping rootstock the hold and the nourishment it requires. *Trichomanes scandens*, L., again, though its fronds also hang down, has not the slender footstalk of those others; it is much stiffer and stronger, and the multifid fronds, a foot long, are firmer in texture, so that they merely droop, instead of being completely pendent. The colour is a golden green, and it is very beautiful as it is seen climbing up the trunk of a tree-fern, the fronds standing out at regular intervals. Like the last, it prefers a lower elevation, and is mostly, if not always, found on the same *Cyathea elegans*. I will only glance at one or two of the smaller species, as an enumeration and description of each of them would be tedious to those who have not seen them growing in their native home, however much one might like to linger over them, and recall the scenes in which they were first observed. Among the small ones there that grow at a height of 5000 ft., one is sure to notice *Hymenophyllum*

*lanatum*, Fée, a tiny thing, with tender pendent fronds about an inch long, which are clothed with soft hairs, and lie imbricated over one another in close patches, which are often very large. It is of a brownish grey colour, like that of *H. sericeum*, and the individual fronds are in shape like the feathers drawn from a small bird's breast. The only other it could be confounded with is *H. hirsutum*, Sw., which has also little pendent fronds, forming large patches, but they are longer, of a different colour, and more divided. But none of the small ones surpass *H. elegantissimum*, Fée, in beauty, with its very narrow, slightly divided fronds and wavy margins. It is a perfect gem; but I must allow the dried specimens to speak for themselves, although fronds separated for drying cannot give an idea of the beauty of a mass of it with every frond hanging down distinct. I must pass over, merely naming them—*H. fucoides*, Sw.; *H. polyanthos*, one of the most abundant everywhere in the island above 1500 ft.; *H. clavatum*, Sw.; *H. axillare*, Sw.; *H. lineare*, Sw.; and *H. hirtellum*, Sw. With regard to *H. ciliatum*, Sw., which is frequent in Jamaica, I found on the Soufriére, in St. Vincent, a fern which answers very closely to the description of *H. ciliatum*, but differs so greatly in size as to be entitled to rank at least as a distinct variety. The fronds of the Jamaican *H. ciliatum* are stated by Mr. Jenman to have a length of from one and a half to three and a half inches, whereas my Soufriére form attains a length of from six to ten inches, and was found growing, not only on logs, but also on the ground. There did not seem to be anything special in the nature of the habitat to account for this great increase of size. This St. Vincent plant was quite the most beautiful of the larger Hymenophyllums I saw in the West Indies. We were fortunate in finding, in the short time at our disposal, fourteen out of twenty-three species of Hymenophyllums that occur in Jamaica; two of the others have been only once found, and there remain only seven, which are not rare, and would probably have been found by us had our opportunities been greater.

Of twenty-five species of *Trichomanes* described by Mr. Jenman as occurring in Jamaica, we succeeded in discovering seventeen, or perhaps sixteen, for I am not sure, of

*T. reptans*, Sw. Three, at anyrate, of these, however—*T. pinnatum*, Hedw.; *T. spicatum*, Hedw.; and *T. Kaulfussii*, Hook. and Grev., I did not see in Jamaica at all. *T. pinnatum* is perhaps not found there; *T. spicatum* is very rare, and so is *T. Kaulfussii*. I found *T. pinnatum* and *T. Kaulfussii* in Grenada, and *T. spicatum* low down on the Soufriére, in St. Vincent. We were not able to find *T. lucens*, Sw., which is a very beautiful fern, and is not uncommon at a high altitude in Jamaica; but a coloured man who was with us picked one plant and brought it to us. Even after that encouragement, however, we did not manage to find another. But we found, either then or afterwards, *T. sphenoides*, Kze.; *T. pusillum*, Sw.; *T. Krausii*, Hook. and Grev.; *T. membranaceum*, L.; *T. sinuosum*, Rich.; *T. crispum*, L.; *T. alatum*, Sw.; *T. Bancrofti*, Hook. and Grev.; *T. pyxidiferum*, L., a very lovely little plant; *T. trichoideum*, Sw.; *T. scandens*, L.; *T. radicans*, Sw.; and *T. rigidum*, Sw.

A class of plants so tender and beautiful as the tropical filmy ferns have naturally attracted fern-growers in this country, but the cultivation of them has been attended with only partial success. One great difficulty has been to obtain healthy and vigorous plants at the outset. They may be sent over in Wardian cases, but then they require to be looked after on the voyage by someone who understands how to manage them; and even then a Wardian case is a bulky and brittle article. If they are packed in a tin box in the ordinary way, it is exceedingly difficult to strike the happy medium between packing them too wet and packing them too dry; and they reach this country either shrivelled up for lack of moisture or blackened by damp, so that only a very small percentage of the plants despatched from the West Indies are fit for growing. But even if you have good plants to start with, it is by no means easy to copy the conditions under which they grow in their native climate. You must give them a warm, moist atmosphere, and not too much light; but the atmosphere ought not to be stagnant; and the tender kinds may very easily be kept too warm and too moist. They are very apt to rot with damp, especially the hairy species like *Hymenophyllum lanatum* and *H. sericeum*, or

you may be just able to keep them alive, without their ever striking away into vigorous growth. Anyone who could discover a method of sending them over to this country in quantity and in a healthy state would find it a paying business; but it is just as well that it is not worth anyone's while to strip the woods of Jamaica of the rarer species with the object of supplying the English market. There is no doubt that the cultivation of these plants is better understood than it was a few years ago, as a proof of which one may point to the small collection in the Edinburgh Botanical Garden, where some of the species are thriving wonderfully well.

If time were of no account one would like, in speaking of the ferns of the high woods of Jamaica, to mention some of the interesting little Polypodiums which grow in positions exactly similar to those of the filmy ferns, dependent from the trunks or boughs of trees. As I have said, the genus *Polypodium* is a very large one in Jamaica, consisting of 79 species, more than fifty of which grow on trees. Some of the largest ones, as, *e.g.*, *P. chnoodes*, Spreng., are very beautiful plants, but to me the most interesting were the smaller ones, growing at a high altitude. I have already mentioned the curious *Xiphopteris serrulatum*, Kaulf., which is really a *Polypodium*, though the *sori* ultimately run into one another and form a continuous line. Then there are *P. gramineum*, Sw.; *P. marginellum*, Sw.; *P. trichomanoides*, Sw.; *P. basi-attenuatum*, Jenm.; *P. moniliforme*, Lag.; the beautifully soft, golden brown *P. cultratum*, Willd.; *P. suspensum*, Linn.; *P. piloselloides*, Linn.; and *P. lanceolatum*, Linn. Most of these could probably be made to grow in this country alongside of the filmies, but, perhaps, they would be even more liable to damp off, and would require a compartment to themselves.

Of the general fern flora of Jamaica, of its various kinds of tree-ferns, of its numerous species of *Adiantum*, *Pteris*, *Asplenium*, *Nephrodium*, *Acrostichum*, which abound in every moist and shady locality, or of the many curious genera that are represented by one species or by a very few, I will say nothing at present, beyond making the general remark that it is amazing to see how freely a large

number of the species are distributed, and the immense number of the individual plants. It has been said that within a radius of one hundred yards you may, in some places, gather specimens of 50 different species. At any-rate, one is greatly struck with the prodigality with which they are scattered wherever ferns will grow—in woods, on shady banks, among rocks, and by streams. The ferns are undoubtedly the features of an island which is luxuriant in all manner of vegetation. Even the casual tourist, who does not know one fern from another, is struck by their multitude and their diversity. Accustomed, as we are, to the very small number of species that can be gathered in any one even of the largest counties of Scotland—in Perthshire, *e.g.*, only 31 at the most—it seems incredible that in Jamaica, which is not double the size of Perthshire by 1200 square miles, one who knew them well could in a very short time gather 300 different species and still leave 173 of the rarer kinds untouched. And the same remarks apply generally, though perhaps in a somewhat less degree, to the only other two of the West Indian islands I visited—Grenada and St. Vincent. Anyone who loves ferns, and has means and leisure, would find that a holiday spent in any of those islands would repay him a thousandfold in the interest and pleasure he would experience at the time, and in a store of delightful recollections which would be a cherished possession to him all the days of his life.

I will conclude by mentioning two Jamaican ferns, which are of unusual interest. The first is *Schizæa elegans*, Sw., of which I have some very fine specimens on one of the sheets. In Jamaica it is an exceedingly rare fern. It was gathered by Purdie, as Mr. Jenman notes, in 1844, on the Bluevale Mountains, at an altitude of 2000 ft. It was not found again, I think, until quite recently, when it was discovered in a wood by the side of the road that leads from Retirement to Accompong, the settlement of the Moroons. It was there that I was able to secure a number of specimens. It belongs to the same tribe as the common *Anemia adiantifolia*, Sw., of which I also show a specimen, and the no less common *Lygodium volubile*, Sw., which climbs up trees to a height of twenty or thirty feet,

but it has the honour of occupying a genus by itself. It is distinguished by its fan-like dichotomously divided fronds, and by its curious fringe-like fertile appendages on the terminal margins, the capsules mixed with chestnut-coloured hairs. It is not so rare, I believe, on the mainland of South America, opposite the West Indian Islands. It was one of the plants brought from Mount Roraima.

The other fern I would mention is still more curious and rare, and I possess only a single small frond of it. It was originally discovered by my friend, Mr. E. F. im Thurn, on that same Mount Roraima, from which he brought so many interesting things in 1884, and there is a drawing of it in the Botanical Transactions of the Linnæan Society for July 1887. It has been named *Enterosora Campbellii*, Baker. Three years after its original discovery, it was found in Jamaica "on the tops of high trees in the forests where *Lælia monophylla* grows, Rose Hill and Greenhill Wood, St. Andrew Parish." . It is very like *Polypodium trifurcatum*, Linn., in outward appearance, so much so that it was confounded by the discoverer with that fern. But its fructification is very different. The sori are at first immersed in the substance of the frond, and at length are partially seen on the lower surface through narrow oblique slits, that look as if they had been made with a penknive through the epidermis. There is no other species known. The fronds attain a length of six inches, so that my frond is a very small one, but the peculiar fructification is distinctly seen on it. I am sorry to say I did not find a plant of it. It may be regarded as, at present at least, one of the rarest ferns in the world.

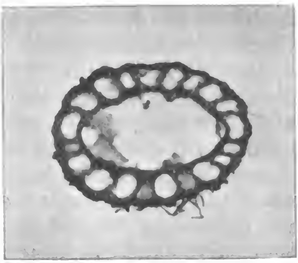
I must apologise for addressing you on a subject that cannot be interesting to all of you, and the fact that our Society does not limit its scope to the flora of our own islands, but concerns itself with the botany of every land, must be my excuse.

*Note.*—In the preparation of this paper I have been greatly assisted by the "Synoptical List, with Descriptions, of the Ferns and Fern-Allies of Jamaica, by G. S. Jenman, Superintendent, Botanical Garden, Demerara," published in the Bulletin of the Botanical Department, Jamaica.

## On the First Recorded Occurrence of Chara Baltica in Scotland. By F. C. Crawford.

(Read 8th November 1900.)

On 31st August 1900, when looking for plants in Loch Stennis, in Orkney, I pulled up a lot of a Chara which was new to me, and I sent it to Mr. James Groves, who replied that it was *Chara Baltica*, Bruzel, and that this was the first record of its having been found in Scotland.



Mr. Groves pointed out that this Chara is a different form to that of var. *affinis*, which is an extreme form, closely bordering on *Chara hispida*, whereas the Loch Stennis plant is much more like the Scandinavian plant.

Mr. Groves also points out "that if you examine the cortex you will notice that the primary series of cells are slightly the more prominent, so that the spine-cells do not appear to be in furrows, as in the *vulgaris* and *hispida* section."

The above micro-photograph shows the uniformity of size in the cortical cells, and the absence of ridges which characterise the *vulgaris* and *hispida* sections.

## Notes on the British Distribution of Glaucium flavum, Crantz, the Horned Poppy. By Alex. Somerville, B.Sc., F.L.S.

(Read 10th January 1901.)

The following notes on the Horned Poppy, *Glaucium flavum*, Crantz, are not submitted because of any rarity of the species, most botanists being acquainted with the plant,

but because it may be spoken of as a 'vanishing quantity,' more so, perhaps, in Scotland than elsewhere in the United Kingdom. This arises, doubtless, not from any natural tendency in the plant itself to extinction (though the fact of so large a species being an annual, and not a biennial or still longer-lived, is suggestive of danger), but that, owing to its size and striking appearance when in flower, it becomes a prey to the ruthless thoughtlessness of the human species. A subsidiary cause, no doubt, lies in the fact that its habitat is the narrow fringe of shingly and shifting soil lying between cultivated ground and the sandy seashore, its territory in consequence being liable to be trespassed on by the plough on the one hand and by the waves *πολυφλοίσβοιο θαλάσσης* on the other. It is thus a child of misfortune, and certainly claims our sympathy and protection.

Within human memory, the Horned Poppy must have been an object commonly to be met with on the shores of the firths both of Clyde and of Forth, wherever situation permitted. How different is the case to-day! So far as the counties bordering on the Clyde estuary are concerned, only at two spots, and at these most sparingly, can lingering plants now be seen, viz. on the Island of Bute, within the enclosed shore area at Mount Stuart, and on the Lesser Cumbrae. Botanists, with the true spirit in them, speak with reserve of the spots on those insular regions where *Glaucium* still blooms. When we turn to the work, published in 1837, by Hewett Cottrell Watson, dedicated to Sir William Hooker, and entitled "The New Botanist's Guide to the Localities of the Rarer Plants of Britain," and look under the head of Dumbartonshire, we find it there stated of *Glaucium flavum*—"on the shore at Helensburgh, plentifully,"—no living botanist, however, whom we know of has ever seen *Glaucium* there, the inroads of civilisation at that point on the Dumbartonshire coast having been too strong for the plant to battle with. Then, if we turn in the work named to Argyllshire, which is taken as including the adjacent islands from Arran to Mull, we find it said—"Arran, abundant,"—but though the writer of this paper and others have worked the Arran coast pretty carefully for many years, *Glaucium* has never been met with in that paradise of botanists and other scientific workers. It is

significant that in the late Rev. Dr. Landsborough's "Excursions in Arran," issued first in 1847, and in Bryce's "Arran," which appeared some years later, in the list of the plants of the island carefully compiled by the now ex-Cabinet Minister, Mr. James Bryce, *Glaucium* finds no place. On the Ayrshire coast opposite, though we find there conditions very favourable for *Glaucium* at points throughout its entire length, we require to-day to go to the extreme south of the county, to the neighbourhood of Ballantrae, before *Glaucium* can be seen.

On the shores of the Forth estuary matters are not much, if at all, better. We examined, last summer, a considerable stretch of suitable coast at Largo Bay, Fife, with the result that, on the littoral margin of the desolate Kilconquhar links, we could find but a single plant of *Glaucium*, from which one or two branches were taken by us, the plant itself, a large one, being left to develop further pods. Coming westward, and crossing the firth into Linlithgowshire, Mr. Sonntag states, in his "Flora of Edinburgh and Surrounding District" (1894), that he found *Glaucium* growing at Blackness, but we know not whether it is still to be found there. Midlothian has long been deserted by the Horned Poppy. In Haddington it occurs, though now exceedingly sparingly.

The latest careful county census of *Glaucium* in Scotland is by Professor Trail in his "Topographical Botany of Scotland," now appearing in the "Annals of Scottish Natural History." The counties which Professor Trail gives are the following, taking the west coast first, viz.—(72) Dumfries; (73) Kirkcudbright; (74) Wigtown; (75) Ayr; (76) Renfrew (in which last it must now be considered extinct); (98) Argyll; and (100) Clyde Isles (*i.e.* Buteshire). We reject his (99) Dumbartonshire record, as the plant is no longer known as occurring in that county. On the east coast the counties are—(81) Berwick; (82) Haddington; *not* (83) Midlothian; (84) Linlithgow; and (85) Fife. There is a doubted record from the inland county (82) Roxburgh, and one from (95) Elgin, and we are informed also by the late Professor Dickie that it at one time grew on the (91) Kincardine coast, but had long been extinct there. Curiously, H. Cottrell Watson mentions a

casual occurrence of *Glaucium* at one locality in Shetland.

In England and Wales there are existing records of *Glaucium* in no fewer than twenty-eight out of the thirty maritime counties, the two exceptions, strange to say, being Northumberland and Durham.

In Ireland the recently-issued second edition of the "Cybele Hibernica," by Messrs. Colgan and Scully, states *Glaucium* to be found on the coasts of almost all Ireland; and that, though local, it is abundant in Dublin and Wicklow, rare in many of the other maritime counties, and absent from the two north-easterly ones—Antrim and Londonderry.

In north-western Europe, Mr. Arthur Bennett, F.L.S., kindly informs us that *Glaucium* occurs at eleven coast localities in south Norway, and in the provinces of Halland and Bohus, in Sweden; in Holland also, though it is rare, and in Belgium, though very rare.

The home of the six species of *Glaucium* known to science is the Mediterranean region. Two only, *G. flavum* and *G. corniculatum*, occur in France, and the same two in Italy; but all six are met with in Syria and Palestine, and are described in Dr. Post's recently issued "Flora of Syria and Palestine." One, *G. aleppicum*, Boissier, has petals of a rich crimson colour, and all, excepting *G. flavum*, are, strange to say, inhabitants, not of the coast-line, but of arid ground inland. *G. arabicum*, Fresenius, is met with in stony places between Jerusalem and Jericho; and *G. grandiflorum*, Boissier, in the valley of the Kedron.

We wish only to refer, in conclusion, to a structural point which strikingly distinguishes the plant with which this paper has to do, viz. its enormous mature pod, which attains to a length of ten, and sometimes even twelve, inches, and which leads to the plant's receiving its English name. This pod is a siliqua, formed of two carpels having parietal placentation. Though structurally one-celled, the ovary becomes two-chambered, owing to a cellular spongy development of the placentas, known only to occur in the genus *Glaucium*.

# ON THE COMPARATIVE STATE OF THE FLORA OF THE WEST HIGHLANDS DURING THE EIGHTEENTH CENTURY AND AT THE PRESENT TIME. By SYMERS M. MACVICAR.

(Read 10th January 1901.)

It is only of late years that zoologists have seen the importance and interest attached to the historical treatment of the fauna of this country, and, so far, only with the larger forms. Their position in this case is a more simple one than that of the botanist, such species of the fauna being comparatively few; and a large part, being easily recognised without much study, have had consequently observers for many years. With plants it is otherwise, but botanists have this advantage, that with their knowledge of plants in their relation to surrounding conditions, they can in many cases determine the probable state of the flora for some previous years, provided they know the former conditions of the surroundings, and have some knowledge of the present flora in its various situations. In a country such as Britain, where there has been established for centuries the same race of men, with only a slow alteration in the methods of cultivation, one cannot expect a rapid change of features in the flora, as has been seen in New Zealand and parts of Australia by the introduction of alien plants and otherwise. The rare instance of the introduction of *Anacharis* into rivers and canals in Britain is limited to districts outside the West Highlands, and the striking features in industrial districts, due to impure air which has altered the distribution of some flowering plants and of lichens, has not affected the district under consideration. If a botanist of the eighteenth century were to visit the West Highlands at the present time, he would doubtless find the most striking difference in the alteration of the position and extent of woods, of agriculture with its accompanying weeds, and in the aspect of the moorland parts of the hills. On a closer examination, the comparative rarity or extinction of certain species, with the introduction or increase of others, would be noted. I have attempted here to show in some degree how these changes have been brought about and are continuing now; the latter in some

cases being simply a continuation of former processes, in some others a reversion in the direction towards the previous conditions. The change in the flora during the short time of a century must rarely be capable of proof, except with those brought about through the influence of man, but this change has probably been greater in the Highlands during the last hundred years than in any other part of Britain.

In every country it is probable that the relative frequency of every species of plant is always altering, but this change is, in normal conditions, usually of too slow a nature to be noted except in a very limited locality. It requires accurate observations to be made, in order that succeeding botanists may profit by the work of those of an earlier time, and even at the present time one cannot help observing the usually vague manner in which the quantity in which species occur is stated. As there is so much difference in the degree of frequency at which plants occur, it is of course difficult to define this degree with what must necessarily be only a few terms; but I think that definite terms might always be used, so that there would be no mistake as to what an author intended by the use of the term he applied. A few progressive numerals, with a distinct meaning, might be attached to such words as "common" and "rare," which would enlarge their signification and yet remain definite.

There is evidence, I think, that some species are decreasing naturally in a more rapid manner than would be expected without being exposed to evident competition with other plants, but it is difficult to understand if this be the case why the plant is not already extinct. A case in point is *Cephalanthera ensifolia.* In Scotland it is rare and local, occurring in widely separated districts, with only a few plants in each locality.

This may be taken as the sign of a species when native once more widely spread, in this case probably when the climate was warmer, but which is now decreasing. In addition to this, in the district in which it occurs, where I know it, it does not appear to form seed in its native site, or when transplanted into the garden; and although it grows on good soil and is sheltered, it is a much smaller plant than south of England specimens which I have seen.

It is dying out in this locality, although the surroundings are apparently unchanged. There is evidence of a similar decrease in other places, as quoted by Mr. G. Claridge Druce in his "Contributions towards a Flora of West Ross," in the Transactions of this Society for 1894, where he refers to the species as follows, in quoting the experience of Dixon at Gairloch:—"The *Epipactis ensifolia*," says Dixon, "formerly abundant, is now almost unknown. In June 1883, I discovered one plant on a stony bank by water. In 1885 two plants were at the same place." This rapid decrease without apparent cause has been noted by botanists in the case of other plants; and if the facts of such decrease are real, the causes can only be ascertained when the relation of the plants to their surrounings are better known.

From the botanists and various travellers during the eighteenth century, we learn of the presence of natural woods in various parts of the West Highlands where none now exist. On the islands there does not appear to have been much more than copses, but on the mainland several places were occupied with large oak woods. The extinction of the copses on the islands seems to have been mainly brought about for the sake of fuel, and for improving cultivation and pasture. In addition to these causes, the large woods on the mainland were destroyed in order to make charcoal for smelting purposes. Woods were not enclosed, so that cattle had free access to them. The effect of this on certain trees, such as the hazel, is to exterminate them after having been once cut down, as the young shoots are greedily eaten, and the plants soon die. With birch this does not occur to quite the same extent, as the shoots are seldom so closely eaten down. On geological formations with a better class of soil, woods and copses have been in many places destroyed, with the idea of improving the pasture, since the introduction of sheep farms during the latter part of the eighteenth century. The effects of the distribution of these woods on the flora of the country has probably been more of a local than of any general nature, as the woods were not of sufficient extent to influence the climate. It must be remembered that the remains of former large woods in peat mosses, so general on the mainland and

on many islands, point to a much more remote period than that which we are considering, but the extinction of the White Beam, *Pyrus Aria*, as a native, and the present rarity of *Prunus Padus* and, perhaps, *Viburnum Opulus*, must be put down to the time we are considering. Herbaceous plants, as *Luzula pilosa*, which require shade, would become locally extinct. The effect on Hepatics would be marked, and, to a less extent, on some species of Mosses. As there have always been woods remaining in some places, as well as other natural shelters, the total extinction of species would be rare; and during the latter half of the century, with the increase of artificial woods, species which require shelter would again find suitable places where hard wood plantations were made. They would have little advantage from the planting of conifers, as this form of plantation until the age of maturity is detrimental to undergrowth. The most important botanical effects of the introduction of firs and larches is the introduction of species of fungi, which only grow in the neighbourhood of these trees. This can be seen at the present time in the Highlands, in any place where such plantations have been made.

The distribution of weeds of agriculture must have much altered since the eighteenth century. At that time crofter holdings were more general over the country, almost every piece of land which could possibly be cultivated bearing the marks of this. Since that time what increase in extent of cultivated land there may be has been mostly limited to enlarging farms, and cultivated areas near farmhouses and townships, so that instead of having cornfield weeds generally distributed throughout the country, we now have them almost limited to such farms and townships. The reclamation of waste ground did not take place to any extent until the introduction of potatoes. This was in 1743, the first locality being in the island of South Uist. The idea of cleaning the fields from weeds was probably first thought of in connection with potato culture, as the Highlanders were then, as now, proverbially careless in this matter. This would introduce a fresh factor in the distribution of certain weeds, as these are generally thrown on to the shores or into rivers; and most of the surprises we now see in the presence of agricultural weeds on or near

the shores in remote places would seldom if ever have taken place before the introduction of potatoes. In forming an opinion as to certain doubtful plants being indigenous in any locality or the reverse, it is necessary to know the manner in which the inhabitants carry on their cultivation. On finding a plant such as *Galium Aparine* or *Polygonum Persicaria* on some remote part of the shore, it is apt to be at once taken as being of the same class of plant as *Festuca ovina*, or any other undoubtedly native species. After an examination for some years of the distribution of the *Galium*, I have come to the conclusion that it not a native of this coast. It is very common on shingly shores, the locality evidently being most suitable for it, but it is always most plentiful on the shores near houses and waste places, and decreases in proportion to its distance from them. Taking this into consideration, with the fact that it is a common weed of cultivation—and I have evidence of its introduction to an island by this means—I cannot regard it as having the same *locus standi* in the flora of the district as a plant about which there is no doubt. It will at times be found in remote places on the shore, but comparatively rarely, and stray plants of oats and potatoes can also be found in such places. I have given the *Galium* as an instance of the care which should be taken in forming an opinion as to plants being indigenous in any locality, as this species seems so much at home on the shingle, and occasionally forms a distinct habit. Many of our species, usually regarded as native, must be placed in the same category as the *Galium*. They differ from the ordinary native vegetation in that their migration bears distinct marks of an introduction by man's agency, though probably often remote; but they are not colonists in the sense of the word as used by Watson, as they have now found a suitable place of growth independent of agricultural operations.

The date of the introduction of cornfield weeds must always be a matter of conjecture, as agriculture has been carried on before there were historical records. Some light is thrown on the subject through observations by former writers. We learn that there was no change of seed when sowing bear, rye, and oats—the only crops of the Highlands. This would prevent the introduction of fresh weeds. Some

alterations there may have been from the present, when flax was cultivated in the West Highlands, as some weeds as *Cuscuta Epilinum* may have occurred which are now absent; but it is probable that the introduction of seed from the south brought with it some new plants. An improved form of oats was introduced into the West Highlands after 1746, but did not become general. Clover and ryegrass, which were introduced as a crop into Scotland about 1700, were not brought into the Highlands until about 1761, and this would introduce new weeds. The presence of *Trifolium minus* in many places must, I expect, date from this time. This is at present a common plant on the coast, but in the majority of its localities it is among sown grass or near it, frequently dying out unless it reaches light sandy ground. *T. hybridum*, which is hardly more than a casual, would also be introduced after this time. *T. purpureum*, a native of light sandy soils, especially on the islands and on the basalt, was also probably introduced, or at least had its distribution extended on other soils, by this means. The introduction of *Campanula rotundifolia* into many places in the schistose formation, and such plants as *Galium mollugo* and *Briza media*, would take place.

Kitchen gardens were first made in the West Highlands in 1734, and from this time must date the introduction of a few annual weeds into the country, as the little disturbed ground of the former gardens for perennial flowering plants would bring with them few extraneous forms. As an instance of a species spreading from kitchen gardens, I have noted *Sisymbrium officinale*, which spreads from gardens to waste places, and then along roadsides. Its introduction is due to accidental mixture with other seeds, as it was not used in the Highlands for its medicinal and carminative properties. *Brassica campestris*, *B. Rapa*, *B. nigra*, and *B. alba*, which are now to be found in many places remote from cultivation, especially along the shores of sandy ground, must date their first appearance to about this time, as no species of this genus were cultivated in the Highlands before this. *B. sinapis*, the common charlock, is still a local plant in many parts of the West Highlands, and is not established so firmly as in many parts of the south, but it may be an older introduction.

The local manner in which agricultural weeds are distributed in the Highlands is interesting. Land around some townships may have abundance of weeds, such as *Viola arvensis* or *Euphorbia Helioscopia*, and they may not be again met with for some miles, the intervening farms or crofter holdings being without them. This points to probable separate centres of introduction, and to the species not being able to spread along the intermediate uncultivated ground. Some species can spread from one village to another along roadsides, as is the case with *Taraxacum officinale* and *Cardamine hirsuta*; but if those centres are only connected by roads through peaty soil without gravel, this extension does not take place. Some effect on the quantity of weeds on cultivated ground must have taken place when a change of manure was introduced in such fields. In the eighteenth century farmers had no byres, consequently no dunghills were formed, and seaware, with occasionally brackens, was the only manure used, and seaware is free from weeds.

A comparison of the flora of existing cultivated ground with that of ground formerly under crops, or on disused crofts, gives some insight into the question of what species are undoubted natives, capable of holding their own with the remainder of the vegetation. When former cultivated areas on exposed sites are examined, we find the flora now to be in no way different from that of the surrounding uncultivated ground, except that there are often more brackens, due to the soil being better than in the surrounding parts. In the shelter of the house walls will frequently be found *Urtica dioica*, *Arctium minus*, and *Cnicus lanceolatus*, a stray plant of the latter occasionally finding its way to the immediate neighbourhood. These plants do not take a firm hold of the ground except where man, cattle, or sheep frequent. Nettles are occasionally seen some distance up the hill, but always in cattle or sheep shelters, natural or artificial. Where the crofts have been in sheltered ground, a few more weeds have been able to retain their hold, but as they are most common in such places, or in ground at present under cultivation, they cannot be considered as being of the same standing as the undoubtedly long-established native flora. Among these may be mentioned

*Rumex obtusifolius, Senecio Jacobæa, Ranunculus repens, Stachys palustris, S. sylvatica, Veronica arvensis, Cerastium triviale, C. glomeratum, Stellaria media, Sagina procumbens, Prunella vulgaris, Polygonum Persicaria, P. Hydropiper,* and *Poa annua. Cerastium triviale* is a very common weed of cultivation, unfrequent far from it. It is also found on hill pastures, where it may be native; but it can be traced up the hills in its following cattle and sheep, and I think it is probably an addition to the flora of the hills of the coast since the introduction of sheep. *C. glomeratum* is an agricultural weed, with a tendency to spread from waste heaps along roadsides. *Sagina procumbens* and *Poa annua* are of a similar class to *Cerastium triviale*, probably long established near man and animals, but with their distribution increased since the introduction of a greatly increased number of animals, viz. south country sheep, at the end of the eighteenth century. These two species can be traced by following the footsteps of cattle and sheep, as also can *Senecio Jacobæa.* In autumn, when cattle are feeding on a pasture where there is much *Senecio*, their necks can be seen to be covered with the seeds, the pappus being conspicuous; the seeds are thus carried for a considerable distance, as I have personally observed. The abundance of *S. Jacobæa* is in proportion to its nearness to houses. When the ground has been left undisturbed for many years, as in deserted crofters' holdings, this plant is comparatively rarely seen, being only able to retain its hold in localities where there is little competition, as on rock ledges and seacliffs. The frequency of alien plants occurring on seacliffs is due to the many bare spots left by weathering, which form suitable ground for the species continuing its existence through seeding in fresh spots before being killed through competition with the native vegetation. *Prunella vulgaris* prefers ground enriched by manure of animals, and although it is doubtless an old inhabitant of the low ground, its occurrence usually in places on the hills affected by sheep show that it must have increased its range with their introduction. The occurrence of *Polygonum Persicaria* and *P. aviculare* in remote places on the shore probably has taken place since the introduction of potatoes, as they are particularly weeds of damp potato ground cultivated in

the usual crofter "lazy bed" system, and are thrown into rivers or on the shore after field weeding. *Stellaria media* can only keep permanent hold in places with little competition, as on shores and floors of caves, or by frequent renewal by being in places much resorted to by animals. It is one of the species that can be traced on moors on the dung of cattle. *Ranunculus repens* is almost confined to ground that has been disturbed by plough or spade. It does not retain its hold for many years on ground that has originally been pasture. Its most permanent position is perhaps by roadside ditches; these are of course occasionally cleaned, and the plant does not spread any distance beyond the disturbed ground. Of weeds as introductions of last century, the most noticeable is *Veronica Buxbaumii*, which Watson considered as having been introduced into Britain about 1825. It is still an uncommon plant on the coast. In two instances I have known it having made its first appearance in gardens, not in cornfields, but it is in the former locality that its appearance would be most readily observed. *Juncus tenuis* is a conspicuous introduction of late years. It is perhaps not sufficiently known to have been often recognised, but as it occurs in three localities with which I am familiar, it most probably is to be found in others. It appears so far to retain its hold when once introduced. The same cannot be yet said of *Potentilla Norvegica*, of which there is evidence of its increasing appearance on this coast.

Before the introduction of haymaking in the West Highlands, about the year 1756, no attention was paid to the kind of grass in fields, and it could only be on the introduction of ryegrass and clover that the plants formerly mentioned as occurring in sown grass fields would be introduced. *Alopecurus pratensis, Phleum pratense, Poa nemoralis*, are also evident introductions to some parts through this means, as well as an increased distribution, if not the introduction, of *Bromus mollis, B. commutatus*, and *B. secalinus*. *B. mollis* spreads from cultivated fields along bare places by roadsides, and it occasionally reaches sandy shores, when it usually becomes dwarfed. *B. commutatus* is a much rarer plant, and remains local in its distribution; while *B. secalinus* appears to be hardly more than a casual.

*Agrostis nigra*, a probable introduction of late years, appears hardly established as yet. Pastures adjoining sandy shores are continually in a state of alteration in some places, especially in the Hebrides, many acres being rendered useless by having been covered by blown sand, on which little now grows except *Psamma arenaria*. The island of Coll has suffered more in this way than any other of the inner islands, a considerable amount of destruction having taken place in the eighteenth century. M'Culloch, in "The Highlands and Western Isles of Scotland," 1824, gives as the reason why Tiree is not much spoiled in this way is that, owing to the island being so flat, blown sand only forms thin layers, there being no uneven ground to form accumulations. The effect of a small amount of sand, containing as it does so much lime, is to improve the pasture. The occurrence on these sandy pastures of certain plants which are most frequent in other places in limestone districts is interesting. A case in point among flowering plants is *Orchis pyramidalis*, which is rare or absent in inland parts of Britain except on limestone, but which also occurs on sandy shores, due, probably, to the lime from the comminuted shells being sufficient for its growth. Among Hepaticæ, I have noticed in such places *Scapania aspera*, considered otherwise almost purely a limestone species; *S. aquiloba*, most frequent on limestone; and *Lejeuna Mackaii*, on rocks coated with blown sand bordering a dune, the last species being also elsewhere most frequently met with on limestone. *Elymus arenarius*, a rare native on the coast, has been planted in a few places to assist in preventing further incursions of the sand; and *Psamma arenaria*, a common native species, has been introduced to some parts where it was absent, or in too small quantity previously. As early as the time of William III., an Act was passed by the Scottish Parliament for the preservation of these two species on the coast, so that it was rendered penal for anyone, including the proprietor, to cut them or even to have them in their possession within eight miles of the coast. This is quoted from Sinclair's "Hortus Gramineus Woburnensis." It is doubtful, however, if these laws were often put in force in the West Highlands. *Elymus* was a rare plant on the coast in the eighteenth century.

Lightfoot does not appear to have met with it. He mentions it in his "Flora Scotica," but in the appendix states that the plant was *Arundo* (*Psamma*) *arenaria*. Walker, in his "Economic History of the Hebrides," mentions *Elymus* as occurring in several parts of the north coast. He gives it for the island of Pabbay, near Broadford, Skye, "where it abounds most," and says that the "foliage when young is eaten down to the very sand by the cattle." This has also been the experience of a proprietor on this coast in recent years, and is perhaps one of the causes of its rarity.

During the eighteenth century, the milk cattle were pastured in summer on the hills, and did not come to the low ground; the more able bodied of the inhabitants living during this time in temporary habitations, termed shielings, close to these pastures. Around these shielings is now only the surrounding native vegetation, with the exception of nettles and a few species which are found in other shelters where sheep resort; but when these shielings were occupied, there must have been an introduction of some of the more ubiquitous weeds which, as in the case of deserted crofts, have since died out. As there was little if any cultivation round these habitations, the introduced weeds would be fewer than in the case of crofts.

A considerable alteration in the flora of the hills must have taken place since the introduction of south country sheep. Previous to this very few sheep were kept, as they had to be housed at night, owing to destruction by foxes and eagles. Some goats, which were more able to withstand these enemies, were kept, but the principal stock was cattle. These were only on the upper parts of the hills in fine weather in summer, and we read of the large amount of herbage which was left uneaten. Consequently, grass and sedges could freely seed, and little if any change in the flora of the hills would take place. On the introduction of large sheep farms all this was changed, as the number of sheep admitted to the hills was only limited by the amount of grass, and several of the rare species now confined to narrow rocks and ledges would, when they had their natural opportunities of seeding, have had a larger distribution. In quite recent years the tendency has been to revert to the former condition on many hills through the introduction of

deer forests, as more herbage is left unconsumed by deer than by sheep. In the lower parts of the hills the introduction of sheep has made a more conspicuous alteration on the flora, as it was only after their introduction that heather burning took place. We read of the heather in the eighteenth century being as high as a man's waist, and we see at the present time, when it is allowed to grow more than a foot or so in height, that the underlying flowering plants are choked and die, but that a great increase takes place in mosses, especially in *Hypnum purum* and *Thuidium tamariscinum*. When large stretches of such parts of the hill ground were thus covered by long heather, other flowering plants, especially grasses, must have been much scarcer than at the present time. By repeated burning in good soil the heather in time becomes destroyed, its place being taken by grass, with a mixture of other flowering plants. In the memory of people living at the beginning of last century, the appearance of hills familiar to them had quite changed from the brown of heather to the green of grass. An increase in the spread of the bracken, unfortunately still going on, is a result of this burning. These changes in the flora, though perhaps sometimes overlooked, have had more important results than would be the case by the presence or absence of some rare species. The diminution of many of these rare species by botanists and others during the last century is a matter of history, but the range of most has been shown of late years to be wider than what was previously supposed.

A later introduction than that of the south country sheep is the rabbit, and the alteration caused by it in the flora must be considerable, though not so conspicuous. In the eighteenth century these animals were scattered over the West Highlands, but only in small quantity. They were, during the latter half of last century, introduced for the sake of sport, and have now generally overrun the low-lying parts. The most noticeable change in the flora which they are making is the destruction of the native holly by barking the stems. So much is this the case that in some districts the continuation of this tree as a native is only effected where seedlings have taken hold of inaccessible rock ledges. This generally implies only a small amount

of soil, with insufficient nourishment for trees to become of any size and to bear much fruit. Among herbaceous plants, an arrested distribution of a rare native species due to these animals has come under my observation in the case of *Mertensia maritima.* In one locality this species occurs on a small island in an arm of the sea, but not on the adjoining mainland. In 1891, one plant made its appearance on the sandy shore of the mainland close to this island. It had found a favourable site, and the plants increased in number for a year or two, and would doubtless have continued to spread but were discovered by rabbits, which destroyed them. As an instance of a prevented spread of an introduced weed, I may give *Lepidium Smithii.* This species appeared among sown grass in 1887, and increased by seeding until 1890, when it was found out by rabbits and exterminated. As these animals now occur in great abundance in many places, similar cases must be frequent, though perhaps not often noticed.

Other changes in the flora since the eighteenth century may be mentioned, such as those caused by draining, increased roadmaking, and more recently by railways. Drainage, except as preparatory to reclamation of land for cultivation, which has already been spoken of, has probably had little effect on the flora of the West Highlands, as, from the nature of the ground and of the kind of soil, only small portions of any locality can be drained. The native vegetation remains unaltered by the larger part surrounding being incapable of permanent improvement, and, except in ground kept under rotation of crops, returns in a few years to its former condition. The effect of making roads is to increase the distribution of certain species which are already in the district; railways, on the other hand, bring new species. The most common communication between districts in the eighteenth century was by footpaths only. These have little effect in increasing the distribution of species. If the paths be through a peaty country, the only plants which increase along them appear to be *Juncus bufonius* and *Carex ovalis.* If the path be in a loamy or gravelly country, we find *Plantago major* spreading along it. The next stage, and the most common means of communication at the present time, is the bridle path or rough cart track. Here,

in addition, several plants are found to spread. The most usually seen are *Cerastium glomeratum*, *C. triviale*, *Sagina procumbens*, *Cnicus lanceolatus*, *Senicio Jacobæa*, *Prunella vulgaris*, *Polygonum aviculare*, *P. Persicaria*, *Plantago major*, *P. lanceolata*, and occasionally individuals of *Capsella Bursa-pastoris*, *Spergula arvensis*, and *Galeopsis Tetrahit*. These are all more or less doubtfully natives, some are undoubtedly introductions, and none of them have the same standing as the genuine native flora. The undoubted native plants which are found on these roads in no way differ from the immediate surrounding flora. The third kind of road in the Highlands, the carriage road, is only noticeable for the increase along it of *Taraxacum officinale* and *Cardamine hirsuta*, and on the parapets and bridges faced with lime of *Asplenium Ruta-muraria*, and the moss *Encalypta streptocarpa*.

For the dates given of the introduction of crops, etc., into the Highlands, I am indebted to Walker's "Economic History of the Highlands," published in 1812 after the author's death. Dr. John Walker, who was appointed to the Chair of Natural History in the University of Edinburgh in 1779, was a naturalist who has not received sufficient recognition. An account of his contributions to the natural history of Scotland would be interesting and instructive.

THE USE OF THE TERM BARK IN RECENT TEXT-BOOKS OF BOTANY. By R. TURNBULL, B.Sc., Extra-Academical Lecturer on Botany, School of Medicine, Edinburgh.

(Read 14th February 1901.)

Until 1884, botanists were unanimous in defining the bark of trees as consisting of all the tissues outside the cambium zone. The popular definition is "everything outside of the wood." These two definitions are practically one and the same, since the cambium is known only to the vegetable anatomist.

In 1884, an English translation of De Bary's "Comparative Anatomy" (1) appeared, and it was found to contain an entirely new definition of bark, viz. "The masses of tissue cut off by the corky layer." This is given on the authority of von Mohl, so that bark, according

to this view, may be regarded as consisting of all the tissues cut off by the phellogen. The aim of this paper is to give evidence in favour of the old English definition, and to show that the translators' definition is founded on a mistranslation.

Numerous excellent text-books and translations have appeared in English since 1884. In these books, one or other of the two definitions has been adopted, according to the choice or belief of the writer or translator of each. The definitions are incompatible, because the whole is greater than its part.

Bark is a word which has the same spelling in Danish and Swedish, and the English form comes from the same root as the Anglo-Saxon "beorgan," to cover or protect. As a purely Anglo-Saxon word it was used by the early English before there was a science of Botany, and it is an unwritten rule that when a popular word with a perfectly defined meaning becomes the technical term of any science, the technical application shall not differ from that in popular use. For example, the wood of many Dicotyledons and Gymnosperms consists of heart-wood (*duramen*) and sap-wood (*alburnum*). No one would be justified in calling the former alone *the wood* of the tree, but it might be called the "dead wood" or "inner wood," as well as heartwood.

In the same way, the bark is what lies outside the wood of the tree, and, generally speaking, the phellogen layer may be regarded as separating the "inner, sap-containing, living bark" from the "outer, dry, dead bark"; but no one would be justified in calling the latter alone *the bark*.

There may be dead fibres in the living bark, and a layer or two of cells immediately to the outside of the phellogen may still live, but these do not affect the general question. The cambium of the botanist is a layer of embryonic or meristematic tissue, which lies between wood and bark. It gives rise to new wood towards its inner side, and new bast towards its outer side. The bast is therefore the inner surface of the bark, and when it contains fibres among its softer tissues, as in the lime-tree, it is spoken of as liber, which has a certain commercial value under the name of bast. Liber, however, is not a term that is now used by English botanists.

When a botanist defines bark as everything outside of the cambium, he does so from a knowledge of the anatomy of the tree. When a forester speaks of the bark as that which lies around the wood, he may be ignorant of the presence of a cambium, but he knows that he can peel the bark from the wood of the tree.

The true meaning of bark is implied in the old proverb—

> "It were a foly for mee,
> To put my hande betweene the barke and the tree." (2)

By tree, in the proverb, is unquestionably meant the wood of the tree. The rough classification of the parts of a tree-trunk into bark, wood, and pith is that of everyday language.

Nehemiah Grew (3), one of the founders of Vegetable Anatomy, said in 1675: "The *Trunk*, or *Branch* of every *Tree*, hath Three General *Parts* to be described; *sc.* the *Barque*, the *Wood*, and the *Pith*. That likewise of every *Herbaceous Plant*, hath either the same Three Parts; or else Three *Parts Analogous*; *sc.* the *Cortical*, the *Lignous*, and the *Pithy Parts*."

From very early times three words have been used in English to denote the same structure, viz. bark, rind, and cortex. Cortex was taken from the Latin without change, and was used in that tongue to indicate the bark as distinguished from the wood of trees. It was used by English botanists of last generation as a synonym for bark, but it has never been a common word among Teutonic races, although its derivative, cork, has long been familiar.

"Cortical system" and "cortical region" are even yet used as synonymous with "bark." The French also use "corticale" in the same sense, and the term is convenient enough so long as one does not mistake it for cortex, which is now restricted in primary axes to the fundamental tissue, which lies between the epidermis and the central cylinder, when it is known as primary cortex. In axes which develop a phellogen, the phelloderma is often called the "secondary cortex."

The French have derived écorce from cortex, and use that word in the same sense as the old English bark.

Rind in English is from the Anglo-Saxon rind or rinde, and the modern German word is Rinde, meaning bark or

crust. The Anglo-Saxon berindan, and the German abrinden, mean to bark a tree, *i.e.* to peel the rind or bark off. It follows from this, therefore, that the rind in English and the Rinde in German are separable from the wood, and are used in the same sense as our *separable bark*.

The modern equivalents in the three languages are—English, *bark*; German, *Rinde*; and French, *écorce*. The Germans have another word, *Borke*, which has the same root as our word, bark, but its application is entirely different, and it is the mistranslation of *Borke* which has led to the erroneous definition of *bark*.

Since bark in English takes the place of Rind in German, both scientifically and popularly, the word rind in English has lost much of its original meaning, and it is seldom used now, except as a name for the separable covering of fruit, such as the rind of an orange or other fruit. Where rind is still used in a purely botanical sense, it is as the synonym of bark.

For the modern terminology of Vegetable Anatomy and Histology, it is best to follow the work of the past ten years; and as it scarcely comes within the scope of this paper to enter into the details of primary and secondary growth in the stems and roots of Spermaphytes, reference should be made to the publications of that period.

The following is naturally an incomplete historical sketch of the use of the term, bark, during the nineteenth century, but it shows conclusively that the old English definition is the correct one:—Martyn (4), 1807—"The inner bark (liber)." Wildenow (5, p. 251), 1811—"The outer bark (cortex) . . . . covers the inner bark (liber) . . . . This is followed by the alburnum, or the soft wood, as it is called." Lindley (6, p. 61), 1832—"The bark is the external coating of the stem, lying immediately over the wood, to which it forms a sort of sheath, and from which it is always distinctly separable." Von Mohl (7), 1836—"Untersuchungen über die Entwickelung des Korkes und der Borke auf der Rinde der baumartigen Dicotylen."

Sachs (18, p. 309) refers to these researches of von Mohl in these terms: "He brought entirely new facts to light by his study of the development of cork and the *outer bark* (*i.e.* Borke) in 1836; these tissues had scarcely

been examined with care till then, and their formation and relation to the epidermis and *cortical tissue* (*i.e.* Rinde) were quite unknown."

The italics and the insertion of the original Borke and Rinde are the writer's.

In the same work, at p. 308, the following precedes the reference to von Mohl:—" A satisfactory conclusion with respect to growth in thickness of the woody body and of the rind was not reached till the history of development in vegetable histology began to be more thoroughly studied." With due caution the translator renders Rinde into rind, which is simply bark in the ordinary sense.

Adrien de Jussieu (8, p. 62), 1845—" Écorce . . . le cambium dessine elle-même un arc qui sépare ce faisceau en deux parties inégales, l'exterieure, appartenant à l'écorce, beaucoup plus étroite que l'interieure, appartenant au bois."

Caspary (9), 1857—" Bewirkt die Sonne Risse in Rinde und Holz der Bäume?" There is no doubt here about the bark and wood being the two chief parts of the tree. If Holz is wood, then a translator, to be consistent, must make Rinde become bark.

J. Hutton Balfour (10), 1859—" Bark (cortex), the outer cellular and fibrous covering of the stem; separable from the wood in Dicotyledons."

The writer has rendered a literal translation of Sachs' Lehrbuch (11, p. 89), 1868—" These cork-lamellæ are, so to speak, scaly or annular flakes cut out of the bark (aus der Rinde); everything which lies upon the outside of the same is dried up, and while by degrees this occurrence at the periphery of the stem often takes place, whereby the new cork-lamellæ always encroach more deeply upon the growing bark-tissue (Rindengewebe), an ever-thickening layer of dried-up tissue-masses (Gewebemassen) is separated from the living part of the bark (von dem lebenden Theil der Rinde); this is the *outer bark* (dies ist die Borke)."

It is evident from the context that Borke is the opposite of the living part of the bark; therefore it might be called the "dead bark," or "dry bark," as well as "outer bark," but it is insufficient to render it into bark.

Hooker (12, p. 20), 1881—" The bast used by gardeners for tying is the inner bark of the lime-tree."

De Bary (1, p. 545), 1884—The chapter on Periderm in "Comp. Anat." is based on von Mohl's researches (7). At p. 545, the following occurs:—"If a layer of cork is formed in the interior of a mass of tissue, the tissue lying outside it dries up, and is eventually thrown off as bark (*Rhytidoma*, Mohl). The formation of bark is the immediate consequence of the internal formation of periderm, and the name is, as a rule, employed for the dried-up tissues and the adjacent peridermal layers conjointly." What is translated here as "bark," is "outer bark" in Garnsey's translation of Sachs' History; and the only way to decide the matter is to refer to the title of von Mohl's work (7), which is in English, "Researches into the Development of Cork and Outer Bark (Borke) in the Bark (Rinde) of Dicotyledonous Trees."

At p. 554 of the same work (1), the term "dry bark" occurs—"The great majority of ligneous plants, however, form on stem or branches new internal periderms, after the first one, which arise successively in deeper layers of the cortex, and cut off successively deeper zones of tissue as *dry bark*." In this sentence the term is correctly used, and one naturally looks for "dry bark" wherever Borke occurs in the original; instead of cortex, however, "cortical zone or region" would be preferable, since "cortex" has now a definite meaning.

The mistranslation of "Borke" into "bark," at p. 545, has led other translators to adopt the same term, so that the majority of translations from the German, and text-books in English, published since 1884, have appeared with the restricted definition of bark.

This influence was seen very prominently in 1887, when the English translation of Sachs' "Physiology of Plants" (13) was published, and to a more limited extent in Goebel's "Outlines" (14). In the former, Rinde becomes *cortex*; Rindengewebe, *cortical tissue*; and Borke, *bark*. In the latter, *bark* occurs only twice, and in italics, as the translation of Borke. (In 1890, the same translator and reviser reject this translation, and use the term *outer bark* for Borke, while Rinde becomes *rind*, which is a synonym in English of the separable bark.)

In the same year, 1887, Asa Gray's "Text-Book" (15),

and the fifth edition of Bentley's "Manual" (16) appeared. The definition of "bark" in the former is—"The rind or cortical portion of a stem, especially of an exogen"; in the latter—"The bark is situated on the outside of the stem, surrounding the wood, to which it is organically connected by means of the medullary rays and the cambium layer." These definitions are correct, but Bentley uses cortex as a synonym of bark. Such a use of cortex is not in keeping with modern terminology, although, as noted above, the two terms were at one time synonymous.

In 1888, the second edition of Bower's "Practical Botany" (17, pp. 115, 116) was published, and the following shows that he still adhered to his conjoint translation of 1884:—"As stems grow older, layers of cork appear successively farther and farther from the external surface: not only the cortex, but also the outer and older portions of the phloëm are thus cut off from physiological connection with the inner tissue: the term *bark* is applied to tissues thus cut off, together with the cork which forms the physiological boundary."

In 1889, Marshall Ward published "Timber" (18). At p. 2—"This log of wood, with its annual rings and medullary rays is clothed by a sort of jacket, consisting of cork and softer tissues, and termed the cortex, or, more popularly, the 'bark' (an unfortunate word, which has caused much trouble in its time)." At p. 199—"It will be remembered that our typical log of timber was clothed in a sort of jacket, termed the cortex, the outer parts of which constitute what is generally known as bark. This cortical covering is separated from the wood proper by the cambium." At p. 206—"Some of these refer to the anatomy of the various 'barks'—the word 'bark' being commonly used in commerce to mean the whole of the cortical jacket,—the places of origin of the cork layer, and the way in which the true bark peels off." Finally, at p. 208, he says—"We have also seen that the cambium is not the only living tissue below the bark: the cortical parenchyma, and the cells of the inner cortex (technically, the phloëm) are all living and capable of growth and division."

Thus, to render his meaning clear, Marshall Ward uses *cortex, cortical covering, cortical jacket,* and "*bark*" to indicate the separable bark in the original English sense; and he uses *dead bark, true bark,* and *bark proper* to point out the region beyond the phellogen. At the same time his language is so clear that it is almost impossible for any reader to mistake his meaning, only there is a danger in the multiplicity of terms; and, on the whole, it would be better to "call a spade, a spade."

In 1890, the translation of Sachs' "History" (18), already referred to, was published. In it, Rinde becomes *rind,* or *bark,* and Borke *outer bark*; but, unfortunately, later translators of other works have returned to the erroneous translation of 1884.

In 1891, Van Tieghem's "Botanique" (19) appeared, and although he emphasises the central cylinder or stele, he makes the terminology more difficult than ever. He takes the popular French word *écorce* (so well defined by Adrien de Jussieu) as equivalent to our word "bark," and restricts it to what we now call "cortex," and, as far as can be seen, he has no term to take the place of what the ordinary Frenchman knows as *écorce.*

Von Mohl first used the term "periderm" to mean the cork tissue formed outside the phellogen, but De Bary suggested the use of the term as applicable to periderm, phellogen, and phelloderm collectively, and in this sense it is now used by most botanists.

In 1894, Scott's "Structural Botany" (20) was published, and, at p. 97, he says—"The whole of this secondary tissue, including phelloderm, phellogen, and cork, is called the *periderm.* The word *bark* is applied to everything outside the phellogen. . . . The bark consists entirely of dead tissues," thus adhering to his conjoint translation of "Borke" in 1884. In this book, no name is given to the region outside the cambium.

In 1896, Francis Darwin published his "Elements of Botany" (21), and, at p. 80, says—"The bark, in the everyday meaning of the word, is that part of the stem external to the cambium. I propose to use the term in this sense, in spite of the fact that in English botanical books it is applied only to the tissue external to the *cork-*

*cambium.*" This is the first protest published against the erroneous definition of bark.

In 1898, Vines issued his "Elementary Text-Book" (22), and, at p. 153, referring to everything outside the phellogen, says—"These dried-up tissues, which may belong to different tissue-systems, and include the most various forms of cells, constitute what is known as *bark.*"

In the same year Strasburger's "Text-Book of Botany" (23) appeared, and gave a similar definition to the preceding.

In 1900, B. D. Jackson (24) defined bark as—(1) "The outer integuments of the wood, and exterior to it; all tissues outside the cambium"; (2) "frequently restricted to the periderm, and tissues external to it."

See also L. H. Bailey's "Botany" (25, p. 265), published in 1900. It adheres to the old English definition.

Evidence enough has been produced to show that there is inconsistency in the use of botanical terms, as they are applied to that region of a secondary axis which lies outside the wood; there is also direct contradiction in the two definitions of bark, and this confusion of terms demands a readjustment.

It may be said that most botanists now follow van Tieghem in recognising epidermis, cortex, and central cylinder in the primary axis of the Spermaphyte.

Cortex, therefore, has lost its position as the synonym of rind or bark.

Since Rinde, in German, and bark, in English, are undoubtedly synonymous, it remains to recognise two regions in this bark; outside of the phellogen is the "dead bark," and between the phellogen and cambium the "living bark." Should there be any difficulty in such a distinction, on the ground that some of the elements of the inner bark are already dead, and that a layer or two of cells outside the phellogen are still alive, then let us speak of the "inner bark" and the "outer bark," with the phellogen layer as the boundary line between them.

The proposed terms have been used by various writers, so that they cannot be objected to as new or additional names; they are consistent with the facts of the case, and we have already the analogy of the division of wood into heart-wood and sap-wood.

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REPORT OF THE EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO KILLIN IN 1900. By Rev. DAVID PAUL, LL.D.

(Read 14th February 1901.)

The Club last year (1900) visited Killin, the neighbourhood of which has already been frequently the scene of its annual excursion. There were present—Mr. William B. Boyd, the President; Dr. Chas. Stuart, Dr. David T. Playfair, Dr. Paul, Messrs. Alex. Somerville, B.Sc., George H. Potts, R. Turnbull, B.Sc., Jas. A. Terras, B.Sc., and F. C. Crawford. Mr. Llewellyn J. Cocks, of Bromley, Kent, was present as a visitor.

On Tuesday, 31st July, two excursions were made; one to Beinn Heasgarnich, and the other to Craig Caillich. The party who visited Beinn Heasgarnich were mainly intent on finding *Carex ustulata*, Willd. Having driven up the Lochay as far as the road permitted, they walked up to the farthest shepherd's house, and following up the burn which joins the Lochay there, passed between Beinn Heasgarnich and Craig Mohr over to the Glen Lyon side. Dr. Paul and Mr. Terras examined the hillside stretching down towards Glen Lyon for *Carex ustulata*, but without success. Their work was much impeded by heavy, continuous rain. The chief plants found during the day, by one or other of the parties, were—*Draba incana*, L.; *Erophila inflata* (Craig Caillich), Watson; *Cerastium alpinum*, L.; *Arenaria rubella*, Hook.; *Dryas octopetala*, L.; *Potentilla rubens*, Vill.; *Saxifraga nivalis*, L.; *Meum athamanticum*, Jacq.; *Cornus suecica* (in fruit), L.; *Trientalis Europæa*, L.; *Carex atrata*, L.; *C. pulla*, Good.; *C. pauciflora*, Lightf.; *Woodsia hyperborea* (Craig Caillich), R. Br.; and *Lycopodium annotinum* (Beinn Heasg.), L.

On the following day, 1st August, a distant expedition was rendered impossible by persistent rain. *Carex remota*, L., and *C. vescicaria*, L., were found in the neighbourhood of Finlarig Castle, and several good mosses were found, including *Habrodon Notarisii*, Schpr., as appears from Mr. Cocks's subjoined report.

On Thursday, 2nd August, it was still raining, but there being promise of improvement in the weather, Drs. Playfair

and Paul, with Messrs. Crawford, Terras, and Cocks, drove to Lochan-na-Lairige, and botanised the crags above the loch, finding—*Trollius Europæus*, L.; *Draba incana*, L.; *Sagina Linnæi*, Presl.; *Vicia silvatica*, L.; *Rubus saxatilis*, L.; *Saxifraga nivalis*, L.; *Epilobium alsinefolium*, Vill.; *Galium boreale*, L.; *Saussurea alpina*, DC.; *Vaccinium uliginosum* (in fruit), L.; *Pyrola rotundifolia*, L.; *Salix reticulata*, L.; *Juncus biglumis*, L.; *Luzula spicata*, DC.; *Carex atrata*, L.; *C. pulla*, Good.; *C. capillaris*, L.; *Agrostis vulgaris*, var. *pumila*, L.; *Avena pratensis*, var. *alpina*, Sm.; *Asplenium viride*, Huds.; *Woodsia hyperborea*, R. Br.; *Polystichum Lonchitis*, Roth.; *Lycopodium alpinum*, L.; and *L. Selago*, L. A few fungi were observed; among them being—*Clitocybe infundibuliformis*, Schæff.; *Omphalia umbellifera*, L.; *Hygrophorus miniatus*, and *Geoglossum glabrum*, Pers.

On Friday, 3rd August, the Club visited Ben Lawers, and found most of the well-known plants of that hill, including—*Arenaria rubella*, Hook.; and *Sagina nivalis*, Fr. The following hawkweeds were found:—*Hieracium murorum*, L.; *H. Anglicum*, Fr.; *H. vulgatum*, Fr.; *H. rivale*, F. J. Hanb.; and the following willows:—*Salix phylicifolia*, L.; *S. phylicifolia* × *nigricans*, Winm.; *S. phylicifolia* × *cinerea*, B. White; *S. nigricans*, Sm.; *S. Arbuscula*, L.; and *S. Lapponum*, L. After the meeting had broken up, Dr. Playfair and Mr. Cocks, who remained at Killin, found *Pyrola secunda*, L.; *Kobresia caricina*, Willd.; and *Melica nutans*, L.

## SUPPLEMENTARY REPORT ON MOSSES. By LLEWELLYN J. COCKS, Bromley Hill, Kent.

By the kind invitation of the President, I had the great privilege and pleasure of joining the 1900 Meeting of the Scottish Alpine Botanical Club at Killin. I devoted the opportunity thus afforded me to the study of the mosses of the district. The ground selected for exploration—the Breadalbane mountains from Ben Lawers to Glen Lochay—is probably the richest in the kingdom in bryophytes, and, as a consequence, it has been more thoroughly explored than any other area, so that it was not to be

expected that a stranger to the country would be able to add much to what had already been recorded.

The first day was an unfortunate one. I accompanied a party which had for its aim the investigation of the ground between Beinn Heasgarnich and Craig Mhor, but our work was brought to an end by thick mist and heavy rain, and, to my disappointment, I had only a very short time among the crags of the latter mountain. I brought away, however, a specimen of the rare *Aulacomnium turgidum*, which was growing among *Hypnum sarmentosum* at the foot of the crags. This is one of the few habitats for *Leptodontium recurvifolium*, which I was not fortunate enough to meet with.

Craig Chailleach, and the neighbouring Ben Cruban, were more accessible, and here I found most of the plants for which these hills are noted, including—*Plagiothecium Mülleri* and *Thuidium Philiberti*—both recently added to our Flora by Mr. H. N. Dixon; *Plagiothecium striatellum*, *Thuidium hystricosum* (rare, I believe, in the North, although a very common moss on the chalk hills of Kent and Surrey); *Plagiobryum demissum* (plentiful, and in beautiful fruit, on the top southern ledges of Chailleach); *Hypnum trifarium*, *H. hamulosum*, and *H. rugosum*; *Cynodontium virens*, var. *serratum*; *Mnium cinclidioides*, and *Splachnum vasculosum*. *Orthothecium rufescens*, although very abundant on dripping rocks on all these hills—a rare sight for southern eyes!—was not found in fruit.

Two visits were paid to Ben Lawers, and the best plants found here, out of many uncommon ones, were—*Eurhynchium cirrosum*, *Brachythecium plicatum*, *Hypnum Halleri* (in fair quantity), *Blindia cæspiticia* (its only British habitat), *Barbula rubella*, var. *ruberrima*; *Amblystegium curvicaule*, var. *strictum*; *Hypnum Bambergeri*, *H. callichroum*, and *H. arcticum*. The last, a rare plant, was abundant in the stream which runs down the western slope of Beinn Ghlas, hanging from the edges of rocks in the small waterfalls.

On the margin of Lochan-na-Lairige, I got *Sphagnum Austini*, Sullivant (*S. imbricatum* of Warnstorf), which I also found on the southern slope of Meall-nan-Tarmachan.

This rare Sphagnum has not, I believe, been recorded previously from Perthshire. *Sphagnum centrale*, Jensen, also rare, or confused with *S. cymbifolium*, I found by Allt Dhubh Ghalair (west of Glen Lochay). By the same beautiful mountain stream, I gathered *Thuidium Philiberti*—a new habitat for this plant.

It was interesting to find *Habrodon Notarisii* still flourishing on the sycamore by Killin Church, among the numerous tin-tacks which have been used for affixing parish notices. Here, I understand, it was first gathered in Britain. It is abundant on trees about Finlarig Castle. In Finlarig Wood, *Ulota Ludwigii* was very plentiful. *Hypnum crista-castrensis* was fruiting near Auchmore. This beautiful moss seems to be fairly abundant in the woods, and among heather, but capsules are exceedingly rare. At the head of the eastern branch of the burn which runs down to Auchmore Bridge, I gathered *Seligeria Donii*—a beautiful little plant—one of our smallest mosses—first found by G. Don, one hundred years ago, in the Den at Dupplin.

Several of the *Sphagna* gathered at this meeting will be found noted by my friend Mr. Horrell, in his papers on the "European Sphagnaceæ," recently completed in the "Journal of Botany."

I should like to be allowed this opportunity of expressing my great gratitude to the Members of the Club for the many kindnesses shown me on this my first visit to the Highlands.

## MOSSES GATHERED IN PERTHSHIRE.

(*Species which are commonly distributed are not noted.*)

Nomenclature of Dixon and Jameson's "Student's Handbook of British Mosses," 1896.

Sphagnum medium, Limpr. (see Jour. of Bot., Jan. 1900)—frequent.
— — Austini—not previously recorded for Perthshire.
Andreæa alpina—frequent.
Oligotrichum incurvum—Meall Ghaordie.
Polytrichum alpinum—frequent.
—— sexangulare—Tarmachan and Ben Lawers.
Diphyscium foliosum—very abundant.
Ditrichum homomallum—frequent.
Swartzia montana—frequent.
Seligeria Doniana—Auchmore Burn.

Cynodontium virens, *var.* serratum—Coire Fionn Lairige.
Dicranella secunda—Ben Lawers.
Blindia cæspiticia—Ben Lawers.
Dicranoweisia crispula—Ben Lawers.
Dicranum falcatum—Ben Lawers.
—— Starkii—Ben Lawers.
—— fuscescens—Ben Lawers.
Fissidens osmundoides—Meall Ghaordie.
Grimmia funalis—frequent.
—— torquata—frequent.
—— patens—frequent.
Rhacomitrium sudeticum—frequent.
Barbula rubella, *var.* dentata—Coire Fionn Lairige.
—— —— *var.* ruberrima—Coire Fionn Lairige.
—— revoluta—Lochay Bridge.
Leptodontium flexifolium—Craig Chailleach (1000 ft.).
Weissia curvirostris—Auchmore Burn.
—— *var.* commutata—Auchmore Burn.
Trichostomum tortuosum, *var.* fragilifolium—Craig Chailleach.
Encalypta commutata—Ben Lawers.
—— ciliata—frequent.
—— rhabdocarpa—frequent.
—— streptocarpa—frequent.
Zygodon Mongeotii—frequent.
Ulota Ludwigii—Finlarig Woods.
Splachnum sphæricum—Meall Ghaordie.
—— vasculosum—Coire Fionn Lairige.
Tetraplodon mnioides—Ben Lawers, Lochan-na-Lairige. Meall Ghaordie, etc.
Meesia trichoides—frequent.
—— —— *var.* alpina—Ben Lawers.
Aulacomnium turgidum—Craig Mhor.
Timmia norvegica—Ben Cruban, Ben Lawers.
Conostomum boreale—Craig Mhor. Meall-nan-Tarmachan, Ben Lawers.
Bartramia Œderi—Craig Chailleach.
—— ithyphylla—Craig Chailleach, Ben Lawers.
Webera elongata—frequent.
—— Ludwigii, *var.* elata—Meall-nan-Tarmachan.
—— cruda—frequent.
Plagiobryum Zierii—frequent.
—— demissum—Craig Chailleach.
Bryum filiforme (c. fr.)—Coire Fionn Lairige.
—— turbinatum—between Ben Lawers and Beinn Ghlas.
Mnium spinosum—Ben Lawers
—— riparium—Ben Lawers.
—— orthorrhynchum—Ben Lawers.
—— cinclidioides—Ben Cruban.
Cinclidium stygium—(barren) Ben Lawers.
Pterogonium gracile—frequent about Finlarig.
Habrodon Notarisii—frequent about Finlarig.
Antitrichia curtipendula—frequent.
Myurella julacea—Coire Fionn Lairige.
—— —— *var.* scabrifolia, Lindb.—Allt Dhubh Ghalair.
—— apiculata—Coire Fionn Lairige.
Pterigynandrum filiforme—Craig Chailleach, Meall-nan-Tarmachan, Ben Lawers.
Heterocladium heteropterum—Finlarig Burn.
Pseudoleskea atrovirens—Ben Lawers (3500 ft.).

Thuidium hystricosum, Mitt. (formerly confounded with T. abietinum).
—— Philiberti, Limpr., first described as British by Dixon, Jour. of Bot., Jan. 1897—Craig Chailleach and Allt Dhubh Ghalair.
Orthothecium rufescens—frequent on mountains.
—— intricatum—Craig Chailleach and Ben Cruban.
Brachythecium plicatum—Ben Lawers (3000 ft.).
Eurhynchium cirrosum—Ben Lawers (3000 ft.).
Plagiothecium pulchellum, *var.* nitidulum.
—— Mülleri, first described as British by Dixon, Jour. of Bot., July 1898—Ben Cruban.
—— striatellum—Ben Lawers and Craig Chailleach.
Amblystegium curvicaule, *var.* strictum—Ben Lawers.
Hypnum Halleri—Ben Lawers (3500 ft.).
—— exannulatum, *var.* purpurascens—Ben Lawers, Meall Ghaordie.
—— vernicosum—Auchmore Burn.
—— sulcatum—Ben Lawers.
—— hamulosum—frequent.
—— callichroum—Ben Lawers.
—— Bambergeri—Ben Lawers.
—— molluscum, *var.* erectum.
—— crista-castrensis—frequent in woods, and among heather on the hills.
—— arcticum—Beinn Ghlas (3000 ft.).
—— ochraceum—frequent.
—— stramineum—frequent.
—— trifarium—Craig Mhor, Craig Chailleach, Beinn Ghlas, Ben Lawers.
—— sarmentosum—frequent.
Hylocomium rugosum—Craig Chailleach, Ben Cruban, etc.

## GIGLIO-TOS'S THEORY OF LIVING MATTER.[1]

By R. A. ROBERTSON.

(Read 14th March 1901.)

"If the parallel surfaces of two bodies be tangential to a cell, and compress it during cell division, what is the effect of the pressure on the direction of the plane of division, division being equal?" Such is one of the biological problems mathematically set and solved by Professor Ermanno Giglio-Tos in his work "Les Problèmes de la Vie," in which he gives his theory of living matter. The fact that he regards vital phenomena as capable of being expressed in mathematical problems like the above, to be solved by mathematical formulæ, at once stamps his theory as a novel one, and stimulates curiosity to know more of it.

His book discusses in detail assimilation and reproduction; the molecule of living matter (biomolecule), its

[1] "Les Problèmes de la Vie." 1re Partie. La Substance vivante et la Cytiodiérèse. Dr. Ermanno Giglio-Tos. Turin.

structure, development, and physiology; the biomore; living matter (bioplasma, biomonad, and cell); cell division and its laws; as well as analytical and complex problems of cell division.

The work from first to last is very carefully thought out, keenly and logically argued, and the whole stated in such a lucid style that, even in the most difficult parts of a difficult subject, there is no ambiguity, and one follows the author with ease, although his course is quite out of the beaten track. It is a book that the biologist will read with profound interest.

"La nature," he says in his preface, "ne nous cache rien. Elle nous présente, au contraire, tous les moyens nècessaires pour dévoiler ses mysterès. C'est à nous de savoir en profiter, en tachant de ne point méconnaître leur valeur." From his standpoint, the phenomena of life are regarded as the natural consequence of chemical, physical, and mechanical phenomena. He deprecates the dragging into hypotheses of special forces, and regards the known chemical laws that govern dead matter as quite sufficient to explain the fundamental manifestations of life. While biologists generally have sought an explanation of vital phenomena in the morphological structure of living substance, in this theory morphological structure is of only secondary importance.

In some slight points it resembles Altmann's granula theory, but goes far beyond it and any of the other well known recent theories. The theory of the cell as the vital unit is gradually losing ground, and Altmann's theory, which regards the cell granules (biomores of Giglio-Tos) as the living units, has many objections. This theory goes beyond Altmann's, in that it regards the molecules of living matter (biomolecules) as the ultimate units. It is not on the physical but the chemical nature of these molecules that an explanation is to be found. The phenomena of life being of the nature of chemical phenomena, it stands to reason that any attempt to explain them by such physical properties as morphological structure must fail. A chemical phenomenon is based on the chemical composition of the body, that is, on its molecular structure. "The intimate cause of the characteristic phenomena of life rests

then, not on the physical and morphological structure of protoplasm or its parts, but on the chemical constitution of living substance, that is, on the structure of its molecules." Chemical changes, as exemplified in dead matter, suffice to explain the characteristic phenomena of life.

The simplest living part imaginable is the biomolecule, which differs in constitution in nowise from molecules of other chemical compounds. The molecules are united together by chemical affinity into molecular compounds (biomores), the particles, granules, and microcosmes of the morphological theories. The molecules constituting any biomore form a little symbiotic system, in which the molecules mutually aid each other. The biomores, again, are united into larger groups in a fluid or semifluid matrix, and form living matter or bioplasm. Each mass of bioplasm forms a symbiotic system of biomores, called a biomonad. The cell is a biomonad characterised by the possession of special biomores of a particular chemical character. Symbiosis plays a large part in this theory, and the author regards it as the most important phenomenon of all biology, in which must be sought the key to many important questions in relation to living matter.

To go into the theory in detail.

The author clears the ground by stating in minute detail his interpretation of the two most important vital phenomena—assimilation and reproduction. It is just here, it may be observed, that lies the crux of the whole matter—accept the views on this point and all the remainder inevitably follows. He enumerates all the known types of chemical change, and then proceeds to argue that since living substance contains no chemical element that does not also occur in dead matter, the explanation of vital phenomena (of a chemical nature) must be based on the same types of chemical change as are found in dead matter. Are the most characteristic and fundamental of the vital phenomena—assimilation and reproduction—which appear to lie outside the general laws of chemistry, capable of explanation on any of the known types of chemical change? To this question, unlike most biologists, the author replies in the affirmative.

Assimilation is the phenomenon by which a living

organism in a nutrient solution abstracts substances chemically different from itself, and tranforms them into substances like itself. Dead substances reacting on other compounds are transformed, and lose their individuality; living substance, on the other hand, not only preserves its individuality, but has the power of forming more living substance in the process. Some have credited living substance with a special faculty of making more, but this, as the author points out, is like explaining that opium induces sleep because it is possessed of a special soporific virtue whose nature is to soothe the senses. Attempts to explain it by physical phenomena, such as morphological structure, crystallisation, and osmosis, will obviously lead to no satisfactory result, for the phenomenon is a chemical one, and cannot be explained by physical laws. Osmosis, of course, is very important in vital phemomena and nutrition, but does not explain assimilation, for without the intervention of a chemical phenomenon assimilation could not take place.

Those biologists who have recognised the chemical nature of assimilation have explained it as a contact action, analogous to the formation of sulphuric acid by nitric acid in chambers of lead. The analogy is imperfect. What is the mysterious force which can detach from dead substances the necessary atomic groups, and arrange them so as to form molecules identical with those of living substance? Further, the nitric acid does not form more nitric acid, but sulphuric acid. Further, supposing that living molecules have the power only of forming other similar molecules, this would not explain the phenomena of ontogenetic differentiation. The molecules could not be transformed; from the molecules of an egg would be obtained other molecules of egg, that is an egg.

The living molecules must be admitted to have not only the power of forming other living molecules, similar or slightly different, but also of undergoing modifications during assimilation.

The true basis of assimilation is to be sought and found in the "biomolecule"—the living unit. The author starts to elucidate this point by reference to the life phenomena of a simple unicellular organism. A single micrococcus

may be seen to divide into two; these two are identical to each other, and also to the original micrococcus (considered at the same point of time) by whose division they were produced, because if placed in the same conditions they give the same manifestations of life, and divide in turn. If the mother micrococcus was at its moment of origin from a pre-existing micrococcus composed of a certain number of particular kinds of atoms or molecules, each of the daughter micrococci derived from it by fission is likewise formed of the same number and kind of atoms and molecules; the sum of the atoms and molecules forming the two daughter micrococci will be double the sum of the atoms and molecules of the mother taken at the precise instant of its birth. If the micrococcus be composed of a single molecule, after fission, two molecules will result, equal to each other and identical to the first. The first molecule has not formed another alongside itself, but has, after various transformations, been doubled into two daughter molecules, equal to each other and identical to the first considered before these transformation changes occurred. Similar observations can be made on the microsomes of the cytoplasm and the karyoplasm—they are reproduced by a true process of fission. Since this fission can be verified *de visu* in the smallest living particles, its occurrence may also be granted to the molecules of living substance. Such fissions (*dédoublements*) are known to occur in dead chemical compounds. The molecule of methyl-ethyl-ketone when oxidised splits into two identical molecules of acetic acid. By successive action on these two of acetic acid with perchloride of phosphorus and zinc ethyl, two molecules of meythl-ethyl-ketone result, *i.e.* two molecules similar to each other and identical to the first molecule with which the reaction commenced. The oxygen, perchloride of phosphorus, and zinc ethyl may be regarded as the food supplied to produce this artificial life of the molecule, while the other products of the reaction—oxychloride of phosphorus, hydrochloric acid, and chloride of zinc may be taken as the secreta of the molecule during this process of assimilation.

Starting with one molecule, we have ultimately obtained two molecules of the same substance. The first one has

assimilated and reproduced; it is nourished at the expense of substances different from itself, as is the case with the micrococci and other organisms.

So the primitive molecule, which constituted the micrococcus, has undergone a series of special chemical changes until a phase is reached when it contains double its original number of atoms, whereupon it splits into two daughter molecules, each with the same number of atoms as the mother had at the beginning. If $a$ indicates the constitution of the molecule at the instant of its birth, its new constitution, after a series of chemical changes, at the instant of *dédoublement* may be represented by $M$. The life cycle of the molecule may be diagrammatically represented as under—

$$a \quad . \quad . \quad M = a + a$$

Two phenomena are noticeable here—

(1) A doubling of the primitive molecule $a$, which has been transformed into $M$, *i.e.* into two other molecules, $a$ $a$. This is a true *reproduction.*

(2) A transformation of the molecule $a$ into $M$, by a series of chemical changes, during which molecule $a$ has doubled the number of its atoms. This is *assimilation*, of which reproduction is the end result.

The author regards this analogy between the chemical phenomena of the methyl-ethyl-ketone molecule and the vital phenomena of the micrococcus as perfect, and concludes, therefore, that, on ultimate analysis, assimilation and reproduction are chemical phenomena.

Since these phenomena can be artificially induced among dead chemical substances, why suppose a special force necessary to explain them? The action of chemical affinity, which produces chemical changes in dead matter, suffices of itself to give an explanation.

To the query of why, if capable of assimilation and reproduction, is the molecule of methyl-ethyl-ketone not living? the answer is given that the conditions of its existence are not realised, or not realisable, in nature. From the study of the artificial life of this molecule, the necessary conditions of life for a living molecule (biomolecule) are deduced, *i.e.* the conditions necessary for the

accomplishment of the fundamental functions of assimilation and reproduction. These conditions are the following:—

(1) The molecule must be suited by its constitution to be transformed, by aid of assimilation, in such a manner as to split into molecules of a structure like its own.

(2) Food substances must always be present.

(3) The nutritive substances and the secondary products (secreta) must not react to their mutual destruction.

(4) The reactions of assimilation must follow in a regular order.

(5) Physical conditions (light, heat, etc.) must be favourable for each reaction.

The first is the *intrinsic condition*, the others are the *extrinsic conditions*. The last four are the conditions of assimilation; while all, but more particularly the first, are conditions of reproduction.

All these conditions are shown to be realised in nature for the living molecule; and the discussion of the fifth condition brings out the great complexity of the living molecule, and also its very unstable character.

It will conduce to clear understanding to give the author's summary of the results arrived at up to this point. Assimilation and reproduction are both equally chemical phenomena, explainable by the known laws of chemistry. "Reproduction is the fission of a biomolecule, which, after a series of assimilatory changes, undergoes *dédoublement* into other molecules having the same structure as the original molecule." "Life is not absolute, it is only relative; it is the resultant of certain intimate relations which must exist between the constitution of the living molecule (intrinsic condition of life) and the physico-chemical conditions of environment (extrinsic conditions of life.)"

Apart from its novelty and ingenuity, one is struck by the completeness, definiteness, and simplicity of our author's explanation of the phenomena of assimilation, or formation of living matter, as contrasted with the obscurity that prevails in most other theories. Compare it with that in plant physiology, where the proteids formed during constructive metabolism are, in some unexplained way, transformed into living substance by the already existing

living substance of the cell; that is to say, a contact action takes place, of the nature of a continual miracle, whereby the touch of the living matter raises the dead matter to life.

*Biomolecular Development.*—Just as in the case of the molecule of methyl-ethyl-ketone, so the biomolecule passes through a series of "phases of biomolecular development." Starting from its origin by fission from a pre-existing biomolecule, it goes on undergoing successive transformations up to the phase of *dédoublement*, when it splits into two daughter molecules. This biomolecular development is expressed in the diagram—

$$a \;.\;.\; b \;.\;.\; c \;.\;.\; d \;.\;.\; M = a + a$$

Here $a$ represents the original molecule, and $b$, $c$, $d$ the successive phases of constitution of the biomolecule during its transformation into $M$, when *dédoublement* occurs. When the resulting daughter molecules, $a$ $a$, are identical to the first $a$, and regenerate it, the development is *autogenetic*, and one biomolecular development completes the "evolutionary biomolecular cycle," and multiplication and reproduction are simultaneous and concomitant phenomena. "Although the simplest imaginable, autogenetic development is neither the easiest nor commonest," because not only has the number of atoms to be doubled, but the atoms have to be arranged so that when doubling occurs each daughter molecule may have its atoms arranged exactly as in the mother molecule, so as to reproduce it in every respect Without this orientation, which is the efficient cause of doubling, metameric compounds would result. The greater the complexity of the molecule, the greater the difficulty in the way of autogenetic development. "When the biomolecule is very complicated, the assimilatory reactions, also, will be very complicated and very numerous, and, as the number of atoms to be doubled is large, the nutritive substances also must be sufficiently complex to supply the biomolecule with the complex atomic groups necessary for its development." Hence the rarity of this mode of development in nature. It occurs only among a few of the simplest organisms—the bacteria, *e.g.*; and hence the necessary complex nature of the food of many of these organisms.

If the biomolecules resulting from *dédoublement* are like each other, but unlike the primitive biomolecule, the development is *homogenetic*, and is figured as under—

$$a' \;.\;.\; b' \;.\;.\; c' \;.\;.\; d' \;.\;.\; M' = e' + e'$$

After further assimilation, $e'$ and $e'$ may each undergo *dédoublement* into two biomolecules which will be identical to $a'$. In this case the evolutionary biomolecular. cycle is composed of at least two homogenetic developments; of course there may be more until the primitive mother molecule is reproduced. In homogenetic development multiplication and reproduction are two distinct phenomena, and are accomplished at different times. In the simplest case, where the cycle is composed of two developments, reproduction only occurs at the second *dédoublement*, where the primitive molecule is quadrupled; while multiplication of molecules (but not reproduction of the original) occurs at the first *dédoublement.* Two phases are thus to be distinguished in homogenetic development—(1) a period of multiplication, extending from the first to the last development; (2) a period of reproduction, in which only the last development is concerned. Multiplication (duplication of the number of molecules) is thus to be carefully distinguished from reproduction (regeneration of the original molecule). The two phenomena are not necessarily concomitant.

When the biomolecules resulting from *dédoublement* are unlike each other, and also unlike the primitive biomolcule, the development is *heterogenetic.* Thus—

$$a'' \;.\;.\; b'' \;.\;.\; c'' \;.\;.\; d'' \;.\;.\; M'' = e'' + i''$$

$e''$, after further assimilation, may undergo *dédoublement*, producing two biomolecules, $a''$ $a''$, identical to the primitive one; while $i''$, although it undergoes further development and *dédoublement*, never regenerates $a''$.

This development is the easiest, and by far the commonest, in nature. The vital cycle is composed of at least two developments, but two kinds of molecules must be distinguished, some able to regenerate the primitive biomolecule after a more or less long series of developments, the others devoid of this faculty. The former are *genetic*, the latter *somatic* biomolecules. The former alone

return, after a vital period more or less long, to the starting-point—never perishing, immortal; the latter never returning to the starting-point—mortal, and destined to perish. Somatic biomolecules, although powerless for reproduction, nevertheless may assimilate and live, and give origin to other different molecules, and ultimately to molecules like themselves.

The results of the two last methods of development, as seen in organisms, are next described. An organism constituted of biomolecules with homogenetic development grows during its vital period by the duplication of its molecules resulting from each *dédoublement.* At the completion of its life cycle, reproduction will ensue; there will be no somatic biomolecules, and the whole body of the organism will take part in the reproduction, which will not be a simple fission but a true sporulation. On the contrary, an organism composed of biomolecules with heterogenetic development at reproduction will be composed of two kinds of biomolecules—the genetic, which will regenerate the primitive biomolecules; and the somatic, taking no active part in reproduction, but which will constitute the "soma" of the organism.

Heterogenetic development is the most frequent in nature, because it is easiest of accomplishment; it lies at the root, and is the prime cause, of ontogenetic differentiation.

For the accomplishment of homogenetic and heterogenetic developments a series of several biomolecular developments is necessary to allow of assimilation, so that the number of atoms may be gradually doubled, and, more particularly, to allow of the gradual orientation of the atoms; so that when *dédoublement* occurs the new molecules may have their atoms linked together in chains similar to those in the primary molecule. The latter is the greatest difficulty, and increases with the size and complexity of the molecules. Thus there are to be recognised "phases of biomolecular preparation" in the evolutionary cycle, during which assimilation goes on, extending from the first to the penultimate development; and "phases of maturation," including the final development, which ends in reproduction. The more complex the

molecule, the greater the number of phases of preparation that must be passed through. In autogenetic development, the cycle includes only a single development, which is at once the phase of preparation and maturation. "Multiplication is the result of the phases of preparation, while reproduction is the final result of the phase of maturation."

In dealing with the *physiology of the biomolecule*, the author takes us over ground of much interest to botanists, and enables us to form exact conceptions of such functions as respiration, starch formation, function of chlorophyll, and secretion. Botanists are accustomed to distinguish the respiratory from the food oxygen in plants, but with this theory there is no such distinction—it is all food oxygen. Respiration, thus, is merely one of the episodes of nutrition, just as the assimilation of carbon, hydrogen, and nitrogen represent others; and since all living substance contains atoms of oxygen in its molecules, respiration is a phenomenon common to all organisms. The element, unlike the other food elements, is absorbed in the uncombined condition. This uniqueness, and the easy demonstrability of the process, have led to its being regarded as a process apart, and to its being dignified by a special name. Respiration being interpreted in a broad sense as the absorption of oxygen free or combined, the so-called anærobia respire, inasmuch as though they do not absorb the free element, they absorb it in the combined state. The suggestion is made that the biomolecules of anærobic bacteria resemble certain easily oxidisable substances, which combine not only with free oxygen, but, on account of their great affinity for this element, can abstract it from other substances with which it is combined. The author epitomises his conception of the phenomenon of respiration in the following words:—"Respiration is not a combustion, it is an oxidation." By combustion is meant here oxidation of carbon atoms. If two atoms of oxygen are absorbed by a biomolecule containing atoms of carbon, these may link on to one atom of carbon, and so satisfying its four valencies, unlink it from the biomolecule, when it will escape as carbon dioxide. If these were the real facts of respiration, the oxygen would be continually abstracting atoms of carbon from the biomolecule, and the latter would gradually be destroyed. In

spite of respiration, however, the processes of assimilation and reproduction continue to go on in the biomolecule, and the number of atoms of oxygen and carbon are regularly doubled. Further, if it were a mere oxidation of carbon atoms, the amount of carbon dioxide given off would equal that of the oxygen absorbed; and the two phenomena—absorption of oxygen and emission of carbon dioxide—would be simultaneously accomplished, the first ceasing, the second would likewise come to an end. To give the prevalent opinion of botanists on this point, we cite from Vine's "Physiology of Plants," p. 196: "There is no such constant relation between the volumes of carbon dioxide exhaled and the oxygen absorbed in respiration, and the processes of destructive metabolism are so complex, that we cannot account for the relation, whatever it may be, between the volumes of these gases in any particular case."

Respiration is an oxidation of the biomolecule—the oxygen is fixed chemically in the biomolecule, and remains there some time. The oxidation of the molecule of methyl-ethyl-ketone is a case in point—the oxygen is fixed in the molecule, and the latter as a result undergoes chemical transformation, whereby it splits into two molecules of acetic acid, without any evolution of carbon dioxide. Disengagement of carbon dioxide is thus not an inevitable result of oxidation; and, further, it may result from other chemical reactions without any oxidation at all, *e.g.* acetic acid reacting on isocyanate of ethyl gives ethyl-acetamide and carbon dioxide. It may be pointed out that botanists generally admit that the evolution of $CO_2$ is not directly connected with the absorption of O. Van Tieghem held this view as far back as 1884. He was led to the same view as the result of experiment as our author has arrived at by theoretical considerations. We might cite here, also, the experiments of De Saussure, Mayer, and Dehérain, which are all in favour of the view that the oxygen is combined with the biomolecule. Succulent leaves of Agave, Saxifrages, Crassulaceæ, stems of Cactus, and fruits were found by these investigators to be able to absorb oxygen without giving off any carbon dioxide in return. "De Saussure found that he could not extract by means of the air-pump

any appreciable quantity of either oxygen or carbon dioxide from a piece of stem of Opuntia which had absorbed about 80 c.c. of oxygen from the air contained in a receiver" (Vines, *loc. cit.*). It would thus appear that the absorbed oxygen was chemically fixed in the plant, and not in a loose chemical combination, or in the form of intramolecular oxygen.

How is the evolution of carbon dioxide to be explained? The view of botanists is given by Vines ("Physiology of Plants," p. 200): "The presence of free oxygen promotes certain processes of destructive metabolism, of which the exhalation of carbon dioxide is an expression." This coincides with the views of our author, which he expresses as follows:—"The oxidation brings about atomic diplacements in the biomolecule, which, consequently, becomes liable to undergo new transformations by other reactions. During the accomplishment of these reactions atomic displacement occurs, and it is possible that two atoms of oxygen may be linked to one of carbon, thus saturating its affinities, when it would be unlinked from the biomolecule and exhaled as carbon dioxide."

"The oxygen which is fixed to the biomolecule and brings about these chemical changes, in the course of which there is exhalation of carbon dioxide, plays the rôle of a true chemical stimulus. The assimilatory reactions which follow oxidation are evidently provoked by the action of the oxygen which produces a whole series of chemical changes, of which the point of departure is oxidation, and the final effect the disengagement of carbon dioxide." The above affords us an easy explanation of the phenomenonon of "intramolecular respiration." "Admitting that oxygen is fixed to the biomolecule, and remains there for some time; admitting that the disengagement of carbon dioxide is not a direct consequence of oxidation but of another assimilatory reaction,—it is obvious that the disengagement of carbon dioxide may go on for some time after the oxygen has ceased to act."

Respiration is characteristic of destructive metabolism. If atoms of oxygen and carbon, as carbon dioxide, are being continually given off from the biomolecule, how is the destruction of the latter averted, and how does the

biomolecule complete its development, so as ultimately to be doubled into two new molecules? It is pointed out that the loss of some atoms "does not always indicate the destruction of a biomolecule, because this same loss may be the cause of a molecular reconstitution or augmentation, simultaneous or subsequent." The reaction, previously referred to, of acetic acid with isocyanate of ethyl, is cited in illustration. Here the acetic acid loses one atom of carbon, but, at the same time, in its transformation it has added three new atoms of carbon from the molecule of ethyl-isocyanate, and has more than made good its loss.

On similar lines, an explanation is afforded of the function of the chloroplasts and of starch formation. The error is pointed out of regarding these two processes, viz. assimilation (in the narrow sense as used by botanists —assimilation of carbon from the carbon dioxide of the air, and emission of oxygen) and starch formation as indissolubly bound together. They are independent of each other, although they may coexist in the same molecule. If the two functions were in absolute connection, the action of the chloroplasts would be of the nature of a contact action to induce the decomposition of carbon dioxide, the carbon of which would unite with the water of the medium, and would form starch or some other carbohydrate, and the molecules of the plastid would play no active rôle in the production. If chlorophyll and starch formation were thus indissolubly bound together, how explain the formation of starch by non-chlorophyllous organisms as the amylogenic bacteria? and, on the other hand, why do certain bacteria possessed of chlorophyll or of bacterio-purpurin form no starch? The error is in linking together two processes which, in reality, can go on quite independently.

"Starchy substances are the products of secretion of biomolecules, that is, the molecules which constitute them are atomic groups, derived in part or *in toto* from the biomolecules in the course of certain assimilatory reactions. We have no right to affirm that the formation of starchy substances takes place entirely outside the biomolecules. Why should it not be admitted that these atomic groups are constituted, in part at least in the interior of the

biomolecules, by successive transposition of the atoms, such as has just been proved in assimilation? The formation of amyloid substances in the biomolecule would thus be comparable with that of carbon dioxide; the atoms of carbon, hydrogen, and oxygen would all, or some at least, be part constituent of the biomolecule before leaving it to form a secretion product. Clearly, on this rendering, the production of starchy substances will depend strictly on the special constitution of the biomolecules and their processes of assimilation. Any biomolecule may produce starch, provided that by its structure and mode of development it can form the atomic groups which represent starch, and if these abandon the molecule after their formation. These conditions not being realised the biomolecules will not give origin to starch, even although from their possession of chlorophyll, or of bacterio-purpurin, they can utilise the carbon of the atmospheric carbon dioxide. Evidently if the carbon of these ternary compounds arises from the biomolecule, it must previously have been supplied to the latter. It is not absolutely necessary that the carbon be assimilated by the action of the chlorophyll or of the bacterio-purpurin, for it might equally well have been absorbed in the combined form, as it is in those non-chlorophyllous organisms which none the less form starch." Chlorophyll and bacterio-purpurin are of course of the highest importance to those organisms which possess them, but merely because they enable the organism to utilise the commonest and most abundant reservoir of carbon—the supply of carbon dioxide of the air, which is a secretion of other organisms.

To summarise the results of the argument—"Chlorophyll and bacterio-purpurin, in favourable conditions of temperature and light, enable the biomolecule to decompose carbon dioxide into its elements; the carbon is fixed to the biomolecules and becomes a constituent part of them. This is the chlorophyll function. Assimilatory reactions produce in the biomolecules displacement of atoms, in the course of which are formed ternary atomic groups which leave the molecules and constitute products of secretion called starchy substances. This is the amylogenic function.

"The amylogenic function is independent of the chlorophyll function, that is, it can go on quite well without it. The atomic linkage characteristic of starchy substances is dependent on the structure of the biomolecules and the chemical change resulting from their processes of assimilation, no matter how the carbon be assimilated. It follows that non-chlorophyllous organisms, as amylogenic bacteria, may nevertheless form starch, while other organisms possessed of chlorophyll or of bacterio-purpurin have not, in spite of the presence of these substances, the power to form carbohydrates."

We may point out that these results, arrived at by theoretical considerations, coincide pretty closely with the views of modern botanists, as determined practically and experimentally. We know, for example, that leukoplasts, which are are non-chlorophyllous plastids, form starch. Further, Bohm ("Bot. Zeit.," 1883) proved, experimentally, that chloroplasts formed starch in the dark when artificially supplied with sugar. Again, from the researches of Ewart ("Jour. Linn. Soc.," 1897), we know that etiolated chloroplasts, without the slightest trace of chlorophyll, show a faint power of carbon-assimilation. Further, as showing that it is not a contact action, Engelmann ("Bot. Zeit.," 1881), by the bacterium method, showed that the actual assimilation of the carbon dioxide probably takes place in the plastid.

The discussion of the food conditions necessary for the artificial life of the chemical molecule is instructive, and suggests interesting considerations as to the rôle played by certain food elements in the nutrition of plants.

The food elements of the biomolecule are classified as follows :—

(1) *The Indispensable.*—These that are actual constituent elements of the molecules.

(2) *Necessary.*—These are part constituent of the molecule only temporarily, their presence being necessary for the completion of subsequent reactions.

(3) *Useful.*—Elements which never enter into the molecule, nevertheless they are useful and necessary for assimilation, inasmuch as they provoke, by their affinity, chemical changes in the molecule.

The first can not be substituted by others; the second and third may, but only within certain limits, for although the substituted element may suit to set agoing the necessary assimilatory changes, yet the secondary products, or secreta of these changes, may be such as to interfere to such an extent as to render the molecule unable to complete its cycle.

To the botanist these remarks are suggestive in reference to the inability of sodium, for example, to replace potassium as a plant food. Again, although potassium is not an element entering into the constitution of living matter, its presence is necessary for perfect plant growth. It would come into types 2 or 3, *i.e.* as temporarily entering into the molecule so as to facilitate subsequent reaction, or, although not entering into the molecule even temporarily, it may act by its affinity to produce important chemical reactions. Similar considerations suggest themselves in reference to the necessity of iron for the proper formation of chlorophyll.

It will be noted in the discussion of starch formation that the significance of the terms assimilation, disassimilation, and secretion is here different from that usually held by botanists. Starch, usually regarded as a product of assimilation, is here classified as a secretion, derived and thrown off from the biomolecules at a particular stage of the assimilatory reactions.

The secretory products fall into two main groups—(1) *Excretory* products: these are never assimilated by the biomolecule, *e.g.* the oxygen evolved during the decomposition of carbon dioxide by the chloroplasts. (2) *Disassimilatory* products: given off by the biomolecules in the course of their assimilatory reactions, *e.g.* the carbon dioxide given off as the end result of respiration.

Attention is then directed to the close relation existing between the food substance, the living substance, and the products of secretion. Disassimilation and secretion are concurrent phenomena of assimilation. There is difficulty in distinguishing between the products of the two processes, and the nature of these products depends not only on the structure of the biomolecules, but also on the chemical composition of the foods. In this connection the varying

behaviour of the same bacteria in different nutrient solutions suggests itself in illustration.

*The Biomore.* — Microscopical examination of living matter, which appears as an emulsion of granules suspended in a fluid medium, leads naturally to the conception of the biomore. Each biomore is a particle composed of biomolecules. "Thus the fine granulations forming the threads of protoplasm, the microsomata of chromatin, of linin, paralinin, perhaps the central corpuscles, micrococci, perhaps also some vegetable plastids, are all probably biomores." Every cell is an aggregate of biomores.

Morphologically the biomores correspond pretty nearly with the *plastidules* of Maggi and Hæckel, the *protoplasmic spherules* of Kunstler, *microsomes* of many biologists, the *granula* or *bioblasts* of Altmann.

Giglio-Tos' biomore theory is not open to the same objections as Altmann's bioblast theory, which he tells us he accepts *in toto*.

Altmann, under his granula conception, includes all kinds of different elements, "not only the usual microsomata in cells, but chloroplastids, pigment granules, lamellar particles in yolk of eggs, oil droplets and fat droplets, particles of ingested food, undigested food stuffs, products of cellular metabolism." Giglio-Tos clearly distinguishes between the biomores and products of molecular secretion and disassimilation, and nutrient substances.

Physiologically the biomores differ from all the granula and morphological conceptions, for, while in the latter the properties of assimilation and reproduction are bound up in the structure of the particles, they are in no way explained by them.

On the other hand, the faculties of assimilation and reproduction, *i.e.* of living, are faculties in no way acquired by the constitution of the biomore. The faculties are inherent in the very parts which compose it,—in the biomolecules, which would be equally living even if isolated.

From direct examination and from theoretical considerations, it is concluded that the biomolecules constituting the biomores are not all alike. The biomolecules are regarded as being bound together into biomores after the same manner as inorganic molecules in molecular combinations

as double salts, *i.e.* on account of the affinity which the atoms or atomic groups of the one molecule have for the atoms or atomic groups of the molecule juxtaposed to it. A mutual attraction thus results, which brings about a well-defined arrangement between the molecules. As the arrangement of the biomolecules in the biomore is thus in close relation with the arrangement of their atoms, it is obvious that their arrangement will be modified by the chemical changes in the molecules, and as the phenomena of assimilation induce these chemical changes, the biomolecules will modify their arrangement in conformability to the new disposition of their atoms. There will thus necessarily be a continual movement of the biomolecules of a biomore during assimilation.

There is in the biomore a state intermediate between the solid and the liquid, because of the mobility of the molecules as in a liquid, and of their definite arrangement as in a solid.

This peculiar arrangement of the biomolecules in the biomore is of importance in the phenomena of assimilation. Not only do the biomolecules increase their instability by it, but they also by their biomoric arrangement create the chemical conditions necessary for their life, and which would not be found if each lived isolated, *e.g.* atomic group *a*, uniting biomolecules A and B in the same biomore may, during assimilatory changes, be attracted from A to B to serve as food; it would then be a secretion product of A. A, on the other hand, might have its development facilitated by removal of atomic group *a*. The two biomolecules would thus mutually aid one another, and would constitute a true mutual symbiosis, and the conditions of their life are better supplied than if each lived separately. This is an extremely simple example of what must really be in the living molecule represented by exceedingly complex conditions.

Morphologically, therefore, a biomore is a union of several biomolecules; physiologically it is a true symbiosis of biomolecules, of which some by their presence facilitate the assimilatory reactions of others, whilst the latter furnish the former with chemical substances necessary for their development.

Thus, in the biomore, there exists a set of conditions—"*the internal biomoric medium*"—produced by the bio-molecules themselves, which renders them more or less independent of the external conditions of environment. This conception of the biomore as a group of biomolecules juxtaposed in a condition of unstable equilibrium, furnishes an easy explanation of the fatal effects of high temperatures on living matter. The biomolecular groups are decomposed, and produce molecular groups different from the biomolecules, and incapable, therefore, of giving origin to vital phenomena.

As showing that the trend of modern botanical opinion is towards some such conception as this biomore, we may quote the following extracts from Pfeffer's "Physiology of Plants" (English translation). On page 32 he says: "It is, as a matter of fact, not inconceivable that the existence of certain species, as such, depends upon protoplastic or symbiotic unions. . . . Nor is the probability excluded that the tiny symbiont might be too small to be visible, or might be unable to continue an independent existence outside of the protoplast." Again, p. 43, speaking of the microsomes he says: "They may be composed in some cases of non-living substance, but in other cases may be minute living plastids. But few of the organs and structural elements of which protoplasm is composed are visible even with the highest powers of the microscope, nevertheless we must conclude, on theoretical grounds, that all living material is built up of most minute living units."

*Bioplasma* is a mass of living matter of any dimensions, composed of any number of biomores, of varied chemical constitution immersed in a liquid matrix—the *interbiomoric liquid.* The conception bioplasma is at once wider and also more restricted than protoplasm, in that it includes all the living granules, not only those of the general cell-body, but the nucleus, central corpuscle, archoplasma, paranuclear corpuscle, in fact all the parts able to assimilate, and consequently to live; it excludes starch, cell-sap, sugars, oil, etc., which do not assimilate, but are merely the result of elaboration of the living parts.

The difficulty of distinguishing the bioplasm from the non-living matters mentioned above is admitted, but the

necessity of drawing such a distinction is emphasised for a clear comprehension of the vital phenomena of ontogeny.

Just as the life of the biomore is the result of the life of its biomolecules, so that of the bioplasm is the result of that of its biomores. As the fundamental phenomena of life—assimilation and reproduction—are purely chemical phenomena, and therefore dependent only on the chemical structure of the biomolecules, it follows that the morphological structure of the protoplasm is of secondary importance.

All the morphological conceptions of protoplasm are compatible with this theory. The bioplasm is composed of biomores synonymous with the granula of Altmann. These granula may be aggregated into threads (Flemming's thread theory), the threads into nets (reticular theory of Frommann), and the interrelation between the reticula and interbiomoric fluid gives alveolar structure (Butschli).

From observations, and on theoretical grounds, he regards the biomores that constitute the bioplasma as not all of the same chemical nature.

The *interbiomoric fluid—cytolinin* of Waldeyer, *interfilary substance* (Flemming), *hyaloplasma* (Leydig), *enchylema* (Carnoy)—is composed essentially of water (not Nageli's water of constitution, but rather of adhesion or capillarity), containing, in solution, nutritive substances, and some of the secreta of the biomores. As these last increase in amount it may acquire a viscous consistency, and have the characters of albuminoid substance. At this stage it would be the equivalent of the trophoplasma of authors, while the ensemble of biomores would represent the kinoplasm.

The fluid serves as the medium of nutritive exchange, in its absence desiccation ensues and assimilation ceases. The absence of water produces no change in the living substance proper—the biomores and biomolecules,—otherwise death would ensue. The exchange recommences as soon as it is supplied, and, with it, the manifestation of life. We have interesting illustrations of this in the behaviour of such organisms as the rotifera, tardigrada, bacteria, etc., in relation to desiccation.

The biomores are alive because they are formed of biomolecules, and the bioplasma is alive because it is formed of biomores. The great heterogenity of the biomores of any mass of bioplasma will render the realisation of their conditions of life a matter of extraordinary difficulty. The biomores of the bioplasm are regarded as forming a symbiotic system, and herein is found a marvellous realisation of their conditions of life. Just as the fungus and alga forming the lichen can live in conditions of environment unsuitable for either separately, so the biomores of the bioplasm, which could not find the necessary conditions of life if separated, realise these conditions by their union in the bioplasm. Their chemical constitution not being uniform, their vital functions will be different, and hence there will be a physiological division of labour —their foods and secreta will vary; thus the secreta of one biomore may be food for another, and reciprocally. O, for example, is a food of the biomolecule, and $CO_2$ a secretion. But $CO_2$ is absorbed by others, C retained and O given off. The latter in turn is absorbed by other biomolecules. So with starch. Starch is a secretion of some biomores, and is absorbed and assimilated by others. Secreta again, of certain biomores, may be ferments to prepare food for others. Thus the author exemplifies the close relation of nutrition and secretion between biomores of the same cell, and emphasises the importance of symbiosis in explaining the manifestation of life. He has a word in passing on the importance of an allied phenomenon —*probiosis*—and its value in the phenomenon of ontogeny. By probiosis he means the anterior life of organisms, in so far as this life has prepared a favourable or necessary environment for other organisms living later, whether of the same or different species, *e.g.* the *probiosis* of lichens and mosses supplies humus for higher plants.

This conception of symbiosis of the biomores of the bioplasm leads to a proper appreciation of the value of the interbiomoric fluid *as the internal bioplasmatic medium.* It acts as a reservoir of food and secreta, and therefore as a medium of nutritive exchange, and renders the biomores independent, in part at least, of the external medium.

The conception of symbiosis implies that of a symbiotic

system—an aggregate of parts living in common, but very distinct in their character. If new individuals be introduced into such a system, the symbiotic equilibrium will be disturbed, and may be destroyed, and this probability of disturbance or destruction will be the greater the more unlike the introduced individuals are to the originals which they replace. This affords an explanation of the phenomena of fertilisation and hybridisation.

Every symbiotic system of biomores is a *biomonad.* The biomonad may be complete, able to regenerate itself in whole or part, *e.g.* the fertilised egg; or incomplete, *e.g.* unfertilised egg and spermatozoid. The cell is a biomonad characterised by the possession of biomores of special chemical nature:—*Karyoplasm* (biomores of nucleus); *Archoplasm* (biomores of centrosphere); *Cytoplasm* (biomores of cell body), and it is by the symbiosis of these that cell life is possible.

Not any one of these parts is more indispensable than the others; if any one be removed, the symbiotic equilibrium is disturbed, or it may be even destroyed. The cell may live, but it will have lost its *vital potentiality*, *i.e.* power to regenerate itself. The same is true of biomore and biomolecule also.

The parts of the cell derive their importance not on account of their morphological structure, their method of aggregation, but because of their chemical constitution, "the parts of the cell really indispensable for life are those which constitute the bioplasma (*i.e.* the biomores), and the interbiomoric fluid. Whatever be the disposition and nature of the biomores, whatever be the form that these biomores may produce by their aggregation in the cell, it will always be indispensable for cell life that the biomores constitute a symbiotic system, and that there exist an interbiomoric fluid whence they can extract their nutritive substances." "The life of the cell is the sum of the lives of its biomores"; and the biomores are incapable of independent life if isolated from each other, just as a cell of a multicellular organism is when isolated from its neighbours, because when isolated it fails to find the necessary condition of existence, which are fully realised in the ensemble of the organism.

"Symbiosis is in fact the fundamental biological principle on which is based the constitution, differentiation, and perfectability of organisms. The symbiosis of biomolecules forms the biomore, that of biomores the biomonad and cell, that of cells the body of the multicellular organism."

The author next introduces us to his interpretation of the phenomena of cell division. The fundamental cause of division is always the same, whether it be the division of a biomolecule or of a biomore, of a biomonad or of a cell —it is the orientation of parts. The orientation of atoms causes the division of the biomolecule, that of biomolecules the division of the biomore, and that of biomores causes the division of the biomonad and the cell. To the objection that the division of the biomolecule is a chemical division, while that of the others is a morphological one, it is pointed out that the molecule is not only a chemical but also a morphological individuality, and it is only our present inadequate means of observation that prevent us from having a morphological conception of the biomolecule. The following diagram may represent the molecules and their relative arrangement of a biomore, A :—

$$
(1)\qquad
\begin{array}{ccc}
 & a & \\
f & & b \\
e & & c \\
 & d &
\end{array}
$$

As assimilation proceeds the chemical composition of the biomolecules will change, and their arrangement, which depends on their reciprocal affinities, will also change, and take the new arrangement of Fig. 2—

$$
(2)\qquad
\begin{array}{ccc}
 & b' & \\
f' & & e' \\
d' & & c' \\
 & a' &
\end{array}
$$

If Fig. (2) correspond to phase *M*, that is, to the final stage just when doubling occurs, then $a'$ will be divided into *aa*, and $b'$ into *bb*, and so on as under—

$$
(3)\qquad
\begin{array}{ccccc}
 & & b\,b & & \\
 & f & & e & \\
f & & & & e \\
 & d & & c & \\
 & & d \quad c & & \\
 & & a\,a & &
\end{array}
$$

In virtue of their reciprocal attraction the biomores will now be oriented, according to their structure, and consequently according to Fig. 1. As each biomolecule, however, is double, their orientation also will be doubled, and will bring about the division of the biomore into two biomores similar to A, thus—

$$(4)\quad \begin{array}{ccccc} & & a & & \\ f & & & & b \\ & e & & c & \\ & & d & & \end{array} \qquad \begin{array}{ccccc} & & a & & \\ f & & & & b \\ & e & & c & \\ & & d & & \end{array}$$

The division of the biomonad and cell takes place similarly. When assimilation has doubled the number of biomolecules the biomores will divide; the system of biomores will then be doubled, and the orientation of the biomores (which is possible because they possess a certain mobility being plunged in a fluid, and because they have a reciprocal attraction in virtue of their chemical constitution) which follows, will induce the division of the biomonad into two new biomonads.

In a series of twenty-one ingenious diagrams we see this gradual orientation of the biomores in biomonad and cell during the successive stages of division leading to the production of the well-known figure of karyokinesis. Cell division is a mechanical phenomenon based on the chemical attraction of the biomores.

Other interesting conclusions in this chapter are, that the centrosphere, and the aster, etc., are ephemeral morphological formations, but materially persistent, *i.e.* the biomores which constitute them always persist as such, although they lose their characteristic arrangement which gives the aster, etc., during the processes of assimilation. The formation of the centrosphere, the asters, the spindle, the nuclear plate, the separation of the chromosomes, and the separation of the two daughter cells, are all phenomena depending on the same cause—orientation of the biomores.

Interesting also are the remarks on the so-called "resting stage of the cell," which ought, according to the author, to be called the "assimilatory period," inasmuch as during this phase the cell is the seat of continual chemical and mechanical work.

In chapter vii. are stated 28 laws of cell division,

rational laws inasmuch as they are not the result of observation, but are deduced with mathematical precision from the interpretation of cell division.

The book concludes with two chapters of problems. Chapter viii. deals with the analytical problems of cell division. Having described in chapter vi. how cell division would be completed under ideal conditions, in these problems are determined the modifications produced by natural conditions. These problems thus deal with the action on cell division of the position of the central corpuscles, of gravity, of external mechanical obstacles, of pressure, of the membrane, of adhesion, of the physiological condition of cells of a cell aggregate. These problems are mathematically set and solved by mathematical formulæ.

The determination of the action of these various conditions paves the way for the solution of the complex problems of cell division—the determination of the segmentation planes of all kinds of eggs when developed in natural and under artificial conditions.

Such is Giglio-Tos's theory, and undoubtedly the author has done his work thoroughly. Every step is fully elaborated, with the result that there is produced a complete and symmetrical whole. When the results arrived at theoretically are borne out by facts of observation, these the author has not failed to note, so that every point is made to tell. As it stands, it affords new views of the much debated subject of cell division, and gives accuracy to conceptions of many physiological phenomena. Whether all the results will be fully proved by the facts of observation and experiment, and whether it gives us the key to the mystery of life, time will tell. Among modern materialistic and chemical theories of life, it must be admitted as *facile princeps.*

One shuts the book with an appetite whetted for more, and looks forward in anticipation and curiosity to the next volume on ontogeny and its problems.

EFFECTS OF WEATHER ON TREE GROWTH. By C. E. HALL.

(Read 9th May 1901.)

In "More Notes on Tree Measurement," published in the "Transactions of the Botanical Society of Edinburgh" in November 1899, an effort was made to trace the effect of variation in meteorological conditions on tree growth, and the conclusion arrived at appeared to be that the most essential factor in the growth of trees is to be found in the rainfall. The present paper is an attempt to analyse the figures published in the communication above referred to in a more detailed manner, and along three different lines. As two of these lines seem to have been based on false foundations, they may be briefly dismissed; the main error of both being that the monthly tree growth taken for comparison with weather factors was the plus or minus growth over or under the average monthly *percentage* of growth. Moreover, as tree-measuring day is the 12th of each month, very rarely the 13th, and as therefore all tree-growth records run from 12th to 12th, and as all meteorological records run from 1st to last day of each month, and considering that possibly weather does not instantly take effect and manifest itself in the girth of a tree, it was determined, in the first line followed, to ignore the lack of correspondence between the growth and weather periods.

The unsatisfactory results of this first line impelled me to work out weather tables from the 12th of one month to the 11th of the succeeding month, and a comparison of growth and weather on this second line was a great improvement on the first line; but when an examination of some peculiar looking cases was instituted, some discrepancies seemed to be quite unaccountable, and then it was that I discovered the error in the tree-growth figures; and for the third attempt, which I shall now further describe, I took for tree growth the plus or minus figures over or under the average *measured* growth for each month. I should say "half the measured growth," as the figures for growth of evergreens and deciduous trees are made up of the mean growths of three pairs of trees of each class.

The basis then of this third attempt to ascertain the effects of weather on tree growth is the accompanying

series of twelve monthly tables, in which the first column gives half the measured monthly growth in millimetres of six evergreens, and the second column the amount plus or minus the average of seven years, the third and fourth columns give the half growth, and the plus or minus average of six deciduous trees. The evergreens are the two Gum trees, two Pines, and two Blackwoods, and the deciduous the two Paraisos, two Oaks, and two Poplars referred to on pages 245, 246, etc. etc. of "More Notes on Tree Measurement." The growth period is from 12th of of one month to 12th of the next.

The five succeeding weather columns represent the monthly amount over or under the average of seven years. The weather period is from the 12th of one month to the 11th of the next month inclusive.

The summaries at the foot of each monthly table show the total net weather factors for that month for all the years when there was an over-average growth, as, also, for all the years when there was an under-average growth.

Thus, for growth period ending 12th February—

Evergreens.

| | Growth. | Thermometers. | | Rain. | | Sun. | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | | |
| | 52·6 | **3·1** | 2·6 | 14·1 | 6·08 | **76** | |
| Over-Average Growth. | 15·6 | **2·9** | **3·0** | 10·1 | 1·81 | 12 | |
| | 4·6 | **0·3** | **1·6** | 4·6 | 1·31 | 37 | |
| | 72·8 | **6·3** | **2·0** | 28·8 | 9·20 | **27** | Net Weather. |
| | **24·4** | 2·5 | 1·1 | **13·9** | **3·0** | 14 | |
| Under-Average Growth. | **21·4** | 1·3 | **1·4** | **10·9** | **3·01** | 19 | |
| | **10·4** | **0·2** | **1·0** | **7·4** | **1·53** | **5** | |
| | **16·4** | 2·5 | 3·2 | 3·1 | **1·66** | **3** | |
| | **72·6** | 6·1 | 1·9 | **29·1** | **9·20** | 25 | Net Weather. |

After constructing these twelve monthly tables, I made a synopsis of all their summaries, which we will call Table I.

And now it may be interesting to show the different results given by the three different attempts to solve this problem, calling them A, B, and C; C being the net totals of Table I., and A and B similar net totals of the Tables embodying the erroneous work—

RESULTS OF THREE SETS OF CALCULATIONS.

EVERGREENS.

| | | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|
| | | | Max. | Min. | Hours. | Inches. | Hours. |
| Over-Averages. | A | 114·4 | **24·4** | 4·4 | 139¼ | 31·39 | **97** |
| | B | 114·4 | **29·9** | 21·3 | 161·5 | 38·65 | **301** |
| | C | 596·3 | **30·9** | 24·6 | 217·6 | 48·83 | **547** |
| Under-Averages. | A | **114·4** | 24·8 | **4·2** | **135·0** | **31·36** | 105 |
| | B | **114·4** | 30·0 | **21·0** | **162·1** | **38·78** | 299 |
| | C | **595·2** | 31·0 | **24·3** | **218·1** | **48·96** | 543 |

DECIDUOUS.

| | | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|
| | | | Max. | Min. | Hours. | Inches. | Hours. |
| Over-Averages | A | 185·5 | **30·3** | **6·3** | 47·0 | 9·88 | 8 |
| | B | 185·5 | **31·2** | **9·1** | 39·7 | 23·64 | 52 |
| | C | 452·4 | **32·0** | 4·5 | 111·3 | 31·82 | **458** |
| Under-Averages. | A | **185·5** | 30·4 | 5·1 | **43½** | **9·78** | ... |
| | B | **185·5** | 31·3 | 9·4 | **39·9** | **23·77** | **54** |
| | C | **451·8** | 32·1 | **4·2** | **111·8** | **31·95** | 456 |

And now, quite disregarding the erroneous A and B, C shows us broadly that a good growth of evergreens is accompanied by a low maximum thermometer. This is doubtless due to the cooling of the air by rain. It is also accompanied by a high minimum thermometer, most likely attributable to the absence of frosts during rainy times; by a considerable plus rainfall, averaging more than 0·22 inch per hour; and, by a lack of sunshine, amounting to twice as many hours as there were plus hours of rain.

We learn, also, from C, or from Table I., that deciduous trees in the main follow the course observed by the evergreens; but the minimum thermometer is only a little above par; the rainfall averages more than 0·28 inch per hour, and the lack of sunshine is more than four times as many hours as the plus hours of rain.

But in the case of the deciduous trees it seems needful to separate them into growing and sleeping periods, as follows:—

| | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. |
| **Over-Average Growth.** | | | | | | |
| Growing Season . | 380·1 | **25·0** | 4·4 | 81·4 | 24·17 | **429** |
| Sleeping Season . | 72·3 | **7·0** | 0·1 | 29·9 | 7·65 | **29** |
| | 452·4 | **32·0** | 4·5 | 111·3 | 31·82 | **458** |
| **Under-Average Growth.** | | | | | | |
| Growing Season . | **380·1** | 24·9 | **4·1** | **82·1** | **24·29** | 428 |
| Sleeping Season . | **71·7** | 7·2 | **0·1** | **29·7** | **7·66** | 28 |
| | **451·8** | 32·1 | **4·2** | **111·8** | **31·95** | 456 |

Sleeping season is estimated from 12th of March to 12th of September inclusive; growing season is, of course, the other six months.

We find from the above little table that the over-average growth of deciduous trees in the growing season is accompanied by a decidedly low maximum thermometer (25 deg. accumulated in six months against 32 deg. in twelve months, as per Table I.); also by a minimum thermometer slightly over par; by an abundant rainfall of nearly 0·30 inch per hour; and by five times as many hours deficiency of sunshine as of over plus hours of rain.

In the sleeping season the maximum thermometer shows a slight deficiency; the minimum thermometer is almost at par; the surplus rainfall is not quite one-third of what it was in the growing season, and is a little over 0·25 inch per hour; and the hours of deficient sunshine are almost equal to the hours of surplus rain. However, as the measured growth of the trees for the six sleeping

months is but 0·093, and the growth in the six growing months is 1·393; and as growth in the sleeping season is complicated with occasional diminutions of girth or shrinkage, probably demanding a separate investigation, it may be best now to attend to the growing season of deciduous trees.

The low maximum thermometer is no doubt attributable to the cooling of the air by rain; but how does a warm minimum thermometer in the six growing months conduce to good growth? Rain, as is probably beyond dispute, is the prime factor of growth, and rain certainly tends to cool the air in the growing season both by day and night, though in the sleeping season the thermometer reads higher during rain than during frosts, which accounts for the high minimum thermometer accompanying good growth of evergreens in the winter months.

Table I.

| | | Evergreens. | | | | | | Deciduous. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Growth. | Therms. Max. | Therms. Min. | Rain. Hours. | Rain. Inches. | Sun Hours. | Growth. | Therms. Max. | Therms. Min. | Rain. Hours. | Rain. Inches. | Sun Hours. |
| Over-Average Monthly Growths. | Feb. 12 | 72·8 | 6·3 | 2·0 | 28·8 | 9·20 | 27 | 88·0 | 6·0 | 0·4 | 24·2 | 7·89 | 64 |
| | Mar. 12 | 74·7 | 8·3 | 0·7 | 10·6 | 4·26 | 57 | 49·0 | 7·0 | 2·9 | 11·9 | 4·87 | 76 |
| | April 12 | 50·7 | 0·8 | 1·5 | 34·2 | 3·29 | 41 | 15·2 | 1·7 | 1·8 | 1·7 | 0·08 | 29 |
| | May 12 | 43·9 | 3·7 | 0·4 | 13 5 | 5·43 | 56 | 18·8 | 2·2 | 2·0 | 9·7 | 1·71 | 3 |
| | June 12 | 39·0 | 1·7 | 10·7 | 42·3 | 2·99 | 71 | 2 0 | 0·2 | 2·0 | 12·9 | 0·59 | 28 |
| | July 12 | 18·0 | 1·7 | 0·7 | 29·1 | 1·55 | 37 | 10·8 | 1·1 | 1·4 | 13·9 | 0·57 | 16 |
| | Aug. 12 | 44·4 | 2·4 | 2·3 | 15·1 | 0·58 | 21 | 9·2 | 7·5 | 3·8 | 7·2 | 3·71 | 13 |
| | Sept. 12 | 41·4 | 0·5 | 0·2 | 16·2 | 4·77 | 26 | 16·3 | 0·1 | 3·3 | 12·1 | 1·15 | 2 |
| | Oct. 12 | 50·2 | 2·4 | 6·9 | 28·7 | 9·15 | 81 | 85·2 | 2·2 | 3·9 | 0·7 | 1·41 | 141 |
| | Nov. 12 | 21·8 | 1·0 | 2·0 | 6·2 | 0·80 | 56 | 35 4 | 6·0 | 1·1 | 0·6 | 0·02 | 31 |
| | Dec. 12 | 64·6 | 3·8 | 2·0 | 11·5 | 4·91 | 79 | 84·8 | 9·1 | 0·6 | 19·0 | 4·63 | 45 |
| | Jan. 12 | 74·8 | 10·1 | 1·0 | 24·0 | 4·66 | 47 | 87·7 | 6·7 | 3·3 | 26·2 | 5·35 | 72 |
| Net | Totals . | 596·3 | 30·9 | 24·6 | 217·6 | 48·83 | 547 | 452·4 | 32·0 | 4·5 | 111·3 | 31·82 | 458 |
| Under-Average Monthly Growths. | Feb. 12 | 72·6 | 6·1 | 1·9 | 29·1 | 9·20 | 25 | 88·0 | 5·8 | 0·3 | 24·5 | 7·89 | 62 |
| | Mar. 12 | 74·4 | 8·0 | 0·6 | 10·7 | 4·29 | 60 | 49·0 | 6·7 | 2·8 | 12·0 | 4·90 | 79 |
| | April 12 | 50·4 | 0·9 | 1·8 | 33·9 | 3·26 | 44 | 15·0 | 1·8 | 2·1 | 2·0 | 0·11 | 26 |
| | May 12 | 43·8 | 4·0 | 0·7 | 13·4 | 5·43 | 54 | 18·6 | 2·5 | 2·3 | 9·6 | 1·71 | 3 |
| | June 12 | 39·0 | 1·6 | 10·4 | 42·2 | 3·00 | 70 | 2·0 | 0·3 | 1·7 | 12·8 | 0·60 | 27 |
| | July 12 | 18·0 | 2·0 | 0·8 | 29·2 | 1·56 | 34 | 10·5 | 0·8 | 1·5 | 14·0 | 0·58 | 13 |
| | Aug. 12 | 44·2 | 2·6 | 2·1 | 14·8 | 0·56 | 24 | 9·0 | 7·3 | 4·0 | 7·5 | 3·73 | 16 |
| | Sept. 12 | 41·2 | 0·3 | 0·4 | 16·1 | 4·77 | 29 | 16·6 | 0·3 | 3·5 | 12·2 | 1·15 | 5 |
| | Oct. 12 | 50·4 | 2·2 | 6·7 | 28·9 | 9·18 | 79 | 35·4 | 2·0 | 3·7 | 0·9 | 1·44 | 139 |
| | Nov. 12 | 22·0 | 0·8 | 2·2 | 6·0 | 0·77 | 56 | 35·7 | 5·8 | 1·3 | 0·4 | 0·05 | 31 |
| | Dec. 12 | 64·3 | 4·0 | 1·7 | 11·5 | 4·92 | 81 | 84·6 | 9·3 | 0·9 | 19·0 | 4·64 | 47 |
| | Jan. 12 | 74·9 | 10·3 | 0·8 | 23·9 | 4·68 | 45 | 87·4 | 6·9 | 3·1 | 26·1 | 5·37 | 70 |
| Net | Totals . | 595·2 | 31·0 | 24·3 | 218·1 | 48·96 | 543 | 451·8 | 32·1 | 4·2 | 111·8 | 31·95 | 456 |

If we look at Table I., we find that the over-average growth of deciduous trees in the growing season is during the months of February, March, and December, accompanied by under-average minimum thermometer, and in October, November, and January by an over-average minimum thermometer. And referring to the monthly tables of plus or minus averages for seven years, we see that the years 1888, 1889, and 1891 are responsible for the October over-average, the years 1888, 1891 for the November over-average, and 1888, 1889 for the January over-average minimum thermometer, as shown in Tables II., III., and IV.

TABLE II.

| | Growth. | Thermometers. | | Rain. | | Sun. | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. | |
| 1888 | 15·4 | **5·3** | 1·2 | 7·4 | 1·79 | **81** | 12th September to 12th October. |
| 1889 | 14·4 | 0·7 | 0·4 | 1·9 | 2·08 | 3 | |
| 1891 | 5·4 | 2·4 | 2·3 | **8·6** | **2·46** | **63** | |
| | 35·2 | **2·2** | 3·9 | 0·7 | 1·41 | **141** | |

Referring to the Meteorological Records, there was a severe hurricane on the afternoon of 2nd September 1888, 3·09 inches of rain falling in three hours. There was also 0·15 inch rain on 3rd September. May we not conclude that the impetus to growth thus given nine days before measuring day was not at that date exhausted, and that the good growth of this period is partly due to the hurricane, whose cooling effects on the air are not felt during this period ending 12th October?

The period ending 12th October 1889 shows both maximum and minimum thermometers so little over par, that, not to be too lengthy, it may be well to pass over this period, and examine the period 12th September to 12th October 1891. The actual rainfall for this period was but 0·67 inch; but in the last twenty-three days of the preceding August there fell 8·45 inches, 4·03 inches

from 8th to 18th, and 4·42 inches from 23rd to 31st August. It is surely reasonable to suppose that the effects of this heavy rainfall had not worn away, and that they account for the slight over-average growth of the 12th October period, the dryness of which causes the high maximum and minimum thermometers.

Table III.

| | Growth. | Thermometers. | | Rain. | | Sun. | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. | |
| 1888 | 25·1 | 1·8 | 5·8 | 3·5 | 0·47 | **77** | 12th October to 12th November. |
| 1889 | 4·1 | **0·8** | **3·8** | **9·7** | **1·27** | 21 | |
| 1890 | 1·1 | 4·1 | **3·3** | **8·2** | **2·08** | 24 | |
| 1891 | 5·1 | 0·9 | 2·4 | 13·8 | 2·90 | 1 | |
| | 35·4 | 6·0 | 1·1 | **0·6** | 0·02 | **33** | |

In 1888 there is a good growth, but very little rain over the average, so the nights had not been much cooled down. But the good growth of this period is no doubt largely due to a heavy rainfall just a day before measuring day, 3 inches being measured at 9.30 a.m. on 11th October.

The rather over-average growth of 12th October to 12th November 1891 is accompanied by an over-average of all weather factors. Now the rainfall of this period was distributed as follows:—1·58 inch from 12th to 31st October; 0·27 inch 1st to 6th November; and 3·34 inches on 8th November. Thus for the first twenty-seven days there was an under-average rainfall, and, in consequence, an over-average temperature, both by day and night. The heavy rain of 3·34 inches does not perceptibly affect the mean temperature, but does affect the growth.

We may perhaps draw the corollary that rainfall affects growth within four days.

Table IV.

| | Growth. | Thermometers. | | Rain. | | Sun. | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. | |
| 1888 | 40·9 | **2·1** | 3·4 | 9·1 | 1·93 | **12** | 12th December to 12th January. |
| 1889 | 42·9 | **2·8** | 0·7 | 23·3 | 4·57 | **55** | |
| 1891 | 3·9 | **1·8** | **0·8** | **6·2** | **1·15** | **5** | |
| | 87·7 | **6·7** | 3·3 | 26·2 | 5·35 | **72** | |

During the period ending 12th January 1888, rain fell on ten days between 13th and 31st of December, 4·15 inches; and 0·93 inch fell on 6th, 7th, and 8th of January. The rainfall being, for San Jorge, decidedly frequent, it is possible that the sun had not as much opportunity as usual to warm the earth sufficiently to produce hot nights; and thus the contrast between a sun-heated earth and a rain-cooled earth is wanting.

Looking now at 1889, the same solution offers itself as in the case of 1888; for the Meteorological Records show that during this 12th January period, from 12th to 31st December, rain fell 2·46 inches on eight days out of the twenty, and 2·72 inches on six days out of the eleven from 1st to 11th January; never more than two consecutive days without rain, except from 25th to 29th December.

The slight over-average growth of the period ending 12th January 1891 is doubtless due to a fall on 10th and 11th December 1890, which would of course take effect after the measurement of trees on 12th December.

Thus in these seven periods, reasons that seem to be good are offered to account for a rather over-average minimum temperature accompanying an over-average growth of deciduous trees during the growing season.

It almost seems as if it were proved that rain is the only one of the weather-factors here taken into consideration that has any actual effect on the growth of trees; a low maximum thermometer in summer is due to rain; a high minimum thermometer (in the case of evergreens) in winter is due to rain; absence of sunshine is due to rain and clouds; all are attendant on good growth, but all are due to rain.

But before dismissing the subject, let us compare some actual growth and weather figures, taking the best growths for each month with corresponding weather, and taking, also, the worst growths for each month, with the month's weather, evergreens and deciduous trees separate as usual, as in Tables V. and VI.

In Table V. (evergreens, 12th May 1888), the poor rainfall (3·11 inches) is supplemented by 4·56 inches, which fell in thirty hours from 2nd to 9th April, three days before the measuring day.

12th November 1888.—The 2·76 inches of rainfall is supplemented by 2·66 inches, which fell in twelve and a half hours from 3rd to 7th October, five days before the measuring day.

12th July 1889.—The poor rainfall of 1·95 inch is supplemented by 3·22 inches, which fell in thirty six and a half hours from 2nd to 10th June, two days before the measuring day.

In the same Table (deciduous trees), 12th November 1888 has been commented upon in "evergreens."

12th December 1888.—The pretty good rainfall of 4·62 inches is helped by a fall of 1·21 inch during seven days from 1st to 11th November; and the evergreen good growth this month is also no doubt helped by the same cause.

As to deciduous trees in the sleeping season, it does not appear that any useful purpose could be served by a detailed examination of these figures, for, as previously remarked, shrinkage takes place in these months, and this cannot be considered simply as if it were intensified bad growth. It may be sufficient to notice that the best growths in sleeping season are accompanied by a total of 32·12 inches, and that the worst growths in this season are accompanied by a total of 20·38 inches, and that the average annual rainfall for these seven years is 44·05 inches.

In Table VI. (evergreens, 12th November 1891), out of the 5·19 inches of rain, 3·61 inches fell in fifteen and a half hours between 1st and 9th November; and the measuring day being 12th November, it is probable that the full effect of this rain had not yet made itself felt.

12th May 1893.—Out of the 5·53 inches of rain, 1·32 inch fell in five hours on 7th May; but even supposing the effect of this had not been fully exhausted, still the month had had a good rainfall. Why then the poor growth?

12th August 1893.—There is a good rainfall of 5·01; and in this case there had been no rain since 30th July. Again, why the poor growth?

In this Table VI. (deciduous trees, 12th November 1892), out of the 3·88 inches of rainfall, 3·41 inches fell from 4th to 9th November, three days before measuring day. Manifestly this rainfall had not had time to effect its full benefit. And for sleeping season, reference to this has been made in the remarks on Table V.

Thus in the thirty-six cases of best and worst growth, eight that seem to run counter to the general rule of "heavy rain, good growth; light rain, bad growth," have been reasonably explained, though no explanation is offered for two other cases. And still it seems as if rain were the sole factor of growth, temperature and sunshine being merely accessories. This is hard to believe; for to what but to sun and heat, added to abundant rain, can be attributed the luxuriant growth of the tropics? And to what but to the lack of heat can be attributed the meagre growth of high latitudes? But the connection between sun and warmth and good growth does not appear from all the foregoing investigations, save in one little point. It will be noticed in the figures with which I shall conclude that minimum thermometer is lower in the worst growth cases, both in evergreens and deciduous trees.

| | EVERGREENS. | | | DECIDUOUS. | | |
|---|---|---|---|---|---|---|
| | THERMOMETERS. | | SUN. | THERMOMETERS. | | SUN. |
| | Max. | Min. | Hours. | Max. | Min. | Hours. |
| Best Growths . . | 71·4 | 51·2 | 212 | 75·7 | 55·5 | 227 |
| Worst Growths . . | 72·4 | 48·4 | 266 | 81·0 | 53·5 | 315 |

Table V.

Twelve Best Growths, With corresponding Month's Weather.

EVERGREENS.

| | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. |
| Feb. 12, 1889 . | 088 | 81·4 | 62·4 | 35½ | 10·44 | 239 |
| Mar. 12, 1889 . | 094 | 80·2 | 60·2 | 30½ | 8·32 | 207 |
| Apr. 12, 1889 . | 081 | 77·2 | 58·2 | 42 | 7·61 | 224 |
| May 12, 1888 . | 070 | 70·2 | 48·9 | 9½ | 3·11 | 213 |
| June 12, 1889 . | 052 | 62·5 | 45·0 | 67½ | 8·26 | 134 |
| July 12, 1889 . | 026 | 57·0 | 37·9 | 34½ | 1·95 | 152 |
| Aug. 12, 1888 . | 047 | 65·5 | 47·5 | 52½ | 6·52 | 155 |
| Sept. 12, 1888 . | 062 | 64·0 | 44·7 | 43½ | 8·12 | 220 |
| Oct. 12, 1889 . | 091 | 68·2 | 45·0 | 23½ | 5·52 | 235 |
| Nov. 12, 1888 . | 055 | 73·2 | 53·5 | 17¼ | 2·76 | 211 |
| Dec. 12, 1888 . | 072 | 74·0 | 51·8 | 26 | 4·62 | 268 |
| Jan. 12, 1889 . | 072 | 83·0 | 59·2 | 38 | 7·82 | 284 |
| | 810 | 856·4 | 614·3 | 420¼ | 75·05 | 2542 |
| | 067·6 | 71·4 | 51·2 | 35 | 6·25 | 212 |

DECIDUOUS.

| | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. |
| Feb. 12, 1889 . | 087 | 81·4 | 62·4 | 35½ | 10·44 | 239 |
| Mar. 12, 1889 . | 055 | 80·2 | 60·2 | 30½ | 8·32 | 207 |
| Apr. 12, 1888 . | 012 | 78·3 | 57·0 | 38 | 6·49 | 274 |
| May 12, 1891 . | 011 | 69·2 | 47·4 | 29 | 7·02 | 220 |
| June 12, 1890 . | 003 | 62·2 | 35·2 | 9 | 0·07 | 237 |
| July 12, 1892 . | 009 | 60·5 | 36·6 | 16 | 1·37 | 206 |
| Aug. 12, 1894 . | 009 | 57·1 | 40·5 | 48½ | 9·05 | 140 |
| Sept. 12, 1888 . | 017 | 64·0 | 44·7 | 43½ | 8·12 | 220 |
| Oct. 12, 1888 . | 038 | 62·2 | 45·8 | 29 | 5·23 | 151 |
| Nov. 12, 1888 . | 074 | 73·2 | 53·5 | 17¼ | 2·76 | 211 |
| Dec. 12, 1888 . | 095 | 74·0 | 51·8 | 26 | 4·62 | 268 |
| Jan. 12, 1889 . | 076 | 83·0 | 59·2 | 38 | 7·82 | 284 |
| Growing Season. | 425 | 454·0 | 332·9 | 176¼ | 39·19 | 1360 |
| | 070·8 | 75·7 | 55·5 | 29·3 | 6·53 | 227 |
| Sleeping Season. | 061 | 391·3 | 261·4 | 184 | 32·12 | 1297 |
| | 010·2 | 65·2 | 43·6 | 31 | 5·35 | 216 |

TABLE VI.

Twelve Best Growths, with corresponding Month's Weather.

EVERGREENS.

| | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. |
| Feb. 12, 1888 . | 011 | 87·0 | 60·9 | 7½ | 1·36 | 329 |
| Mar. 12, 1894 . | 011 | 86·4 | 58·1 | 14 | 1·98 | 306 |
| Apr. 12, 1892 . | 039 | 78·9 | 55·0 | 17 | 1·85 | 286 |
| May 12, 1893 . | 027 | 67·8 | 50·3 | 30½ | 5·53 | 165 |
| June 12, 1894 . | 006 | 61·2 | 36·1 | 2½ | 0·44 | 236 |
| July 12, 1892 . | 008 | 60·5 | 36·6 | 16 | 1·37 | 206 |
| Aug. 12, 1893 . | 010 | 60·3 | 41·9 | 39½ | 5·01 | 194 |
| Sept. 12, 1892 . | 022 | 62·5 | 39·3 | 17½ | 0·85 | 250 |
| Oct. 12, 1893 . | 026 | 63·2 | 41·7 | 27½ | 1·75 | 260 |
| Nov. 12, 1891 . | 025 | 72·3 | 50·1 | 27½ | 5·19 | 289 |
| Dec. 12, 1893 . | **004** | 82·2 | 53·6 | ... | ... | 362 |
| Jan. 12, 1890 . | 001 | 86·9 | 57·1 | 8¼ | 2·33 | 312 |
| | 182 | 869·2 | 580·7 | 207¾ | 27·66 | 3195 |
| | 015·2 | 72·4 | 48·4 | 17·3 | 2·30 | 266 |

DECIDUOUS.

| | Growth. | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|
| | | Max. | Min. | Hours. | Inches. | Hours. |
| Feb. 12, 1894 . | ... | 87·0 | 63·0 | 24½ | 2·70 | 312 |
| Mar. 12, 1894 . | ... | 86·4 | 58·1 | 14 | 1·98 | 306 |
| Apr. 12, 1890 . | **004** | 76·6 | 51·9 | 38½ | 4·55 | 268 |
| May 12, 1888 . | **014** | 70·2 | 48·9 | 9½ | 3·11 | 213 |
| June 12, 1894 . | ... | 61·2 | 36·1 | 2½ | 0·44 | 236 |
| July 12, 1893 . | **003** | 56·4 | 38·3 | 23 | 2·69 | 152 |
| Aug. 12, 1892 . | **002** | 64·0 | 42·7 | 32½ | 2·20 | 197 |
| Sept. 12, 1891 . | 001 | 61·3 | 43·9 | 54 | 7·39 | 249 |
| Oct. 12, 1890 . | 010 | 65·2 | 39·8 | 5 | 0·65 | 275 |
| Nov. 12, 1892 . | 027 | 72·8 | 49·8 | 17 | 3·88 | 243 |
| Dec. 12, 1892 . | 002 | 83·9 | 52·8 | 4 | 0·15 | 353 |
| Jan. 12, 1892 . | **004** | 90·9 | 57·3 | 2¼ | 0·46 | 402 |
| Growing Season. | 035 | 486·2 | 320·8 | 67 | 9·82 | 1891 |
| | 006 | 81·0 | 53·5 | 11 | 1·64 | 315 |
| Sleeping Season. | **022** | 389·7 | 261·8 | 160 | 20·38 | 1315 |
| | **004** | 65·0 | 43·6 | 27 | 3·40 | 219 |

## 12TH FEBRUARY.

| | EVERGREENS. | | DECIDUOUS. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 011 | **24·4** | 018 | **8·0** | 2·5 | 1·1 | **13·9** | **3·0** | 14 |
| 1889 . | 088 | 52·6 | 087 | 61·0 | **3·1** | 2·6 | 14·1 | 6·08 | **76** |
| 1890 . | 051 | 15·6 | 053 | 27·0 | **2·9** | **3·0** | 10·1 | 1·81 | 12 |
| 1891 . | 014 | **21·4** | 001 | **25·0** | 1·3 | **1·4** | **10·9** | **3·01** | 19 |
| 1892 . | 040 | 4·6 | 009 | **17·0** | **0·3** | **1·6** | 4·6 | 1·31 | 37 |
| 1893 . | 025 | **10·4** | 014 | **12·0** | **0·2** | **1·0** | **7·4** | **1·53** | **5** |
| 1894 . | 019 | **16·4** | ... | **26·0** | 2·5 | 3·2 | 3·1 | **1·66** | **3** |
| | 248 | 72·8 | 182 | 88·0 | **6·5** | **7·0** | **32·2** | **9·20** | **84** |
| Average | 035·4 | **72·6** | 026·0 | **88·0** | 6·3 | 6·9 | 31·9 | 9·20 | 82 |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 72·8 | ... | ... | **6·3** | **2·0** | 28·8 | 9·20 | **27** |
| Under-Average | | **72·6** | ... | ... | 6·1 | 1·9 | **29·1** | **9·20** | 25 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 88·0 | **6·0** | **0·4** | 24·2 | 7·89 | **64** |
| Under-Average | | ... | ... | **88·0** | 5·8 | 0·3 | **24·5** | **7·89** | 62 |

## 12TH MARCH.

| | EVERGREENS. | | DECIDUOUS. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 028 | **11·1** | 013 | **1·0** | 1·5 | 1·1 | **13·3** | **2·35** | **29** |
| 1889 . | 094 | 54·9 | 055 | 41·0 | **3·1** | 2·2 | 13·7 | 4·48 | **66** |
| 1890 . | 045 | 5·9 | 022 | 8·0 | **3·9** | **5·1** | **1·8** | 0·39 | **10** |
| 1891 . | 013 | **26·1** | 001 | **13·0** | 3·8 | 0·1 | **9·8** | **1·27** | 26 |
| 1892 . | 053 | 13·9 | 003 | **11·0** | **1·3** | 2·2 | **1·3** | **0·61** | 19 |
| 1893 . | 030 | **9·1** | 004 | **10·0** | **0·4** | **0·7** | 15·2 | 1·19 | 30 |
| 1894 . | 011 | **28·1** | ... | **14·0** | 3·1 | 0·1 | **2·8** | **1·86** | 33 |
| | 274 | 74·7 | 098 | 49·0 | **8·7** | **5·8** | **29·0** | **6·09** | 108 |
| Average | 039·1 | **74·4** | 014·0 | **49·0** | 8·4 | 5·7 | 28·9 | 6·06 | **105** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 74·7 | ... | ... | **8·3** | **0·7** | 10·6 | 4·26 | **57** |
| Under-Average | | **74·4** | ... | ... | 8·0 | 0·6 | **10·7** | **4·29** | 60 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 49·0 | **7·0** | **2·9** | 11·9 | 4·87 | **76** |
| Under-Average | | ... | ... | **49·0** | 6·7 | 2·8 | **12·0** | **4·90** | 79 |

## 12th APRIL.

| | EVERGREENS. | | DECIDUOUS. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average. | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 061 | 3·9 | 012 | 7·6 | 1·2 | 1·8 | 9·9 | 1·37 | 5 |
| 1889 . | 081 | 23·9 | 003 | **1·4** | 0·1 | 3·0 | 13·9 | 2·49 | **45** |
| 1890 . | 080 | 22·9 | **004** | **8·4** | **0·5** | **3·3** | 10·4 | **0·57** | **1** |
| 1891 . | 041 | **16·1** | 004 | **0·4** | **0·4** | **0·8** | **4·1** | **1·84** | **10** |
| 1892 . | 039 | **18·1** | 001 | **3·4** | 1·8 | **0·2** | **11·1** | **3·27** | 17 |
| 1893 . | 044 | **13·1** | 003 | **1·4** | **2·8** | **0·8** | **7·1** | 3·30 | 13 |
| 1894 . | 054 | **3·1** | 012 | 7·6 | 0·5 | ... | **11·6** | **1·45** | 24 |
| | 400 | 50·7 | 031 | 15·2 | **3·7** | **5·1** | 34·2 | 7·16 | 59 |
| Average | 057·1 | **50·4** | 004·4 | **15·0** | 3·6 | 4·8 | **33·9** | **7·13** | **56** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | 50·7 | | ... | ... | 0·8 | 1·5 | 34·2 | 3·29 | **41** |
| Under-Average | **50·4** | | ... | ... | **0·9** | **1·8** | **33·9** | **3·26** | 44 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | ... | | ... | 15·2 | 1·7 | 1·8 | **1·7** | **0·08** | 29 |
| Under-Average | ... | | ... | **15·0** | **1·8** | **2·1** | 2·0 | 0·11 | **26** |

## 12th MAY.

| | EVERGREENS. | | DECIDUOUS. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 070 | 27·3 | **014** | **12·4** | 0·4 | 1·0 | **12·1** | **1·27** | **1** |
| 1889 . | 054 | 11·3 | **004** | **2·4** | **3·5** | **0·1** | 18·2 | 4·06 | **59** |
| 1890 . | 038 | **4·7** | **004** | **2·4** | 4·1 | **1·1** | **7·1** | **1·41** | 46 |
| 1891 . | 048 | 5·3 | 011 | 12·6 | **0·6** | **0·5** | 7·4 | 2·64 | 6 |
| 1892 . | 031 | **11·7** | **003** | **1·4** | 1·5 | **2·1** | **8·6** | **3·09** | 17 |
| 1893 . | 027 | **15·7** | 004 | 5·6 | **2·0** | 2·4 | 8·9 | 1·15 | **49** |
| 1894 . | 031 | **11·7** | **001** | 0·6 | 0·4 | 0·1 | **6·6** | **2·08** | 40 |
| | 299 | 43·9 | **011** | 18·8 | 6·4 | **3·8** | 34·5 | 7·85 | 109 |
| Average | 042·7 | **43·8** | **001·6** | **18·6** | **6·1** | 3·5 | **34·4** | **7·85** | **109** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | 43·9 | | ... | ... | **3·7** | 0·4 | 13·5 | 5·43 | **56** |
| Under-Average | **43·8** | | ... | ... | 4·0 | **0·7** | **13·4** | **5·43** | 54 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | ... | | ... | 18·8 | **2·2** | 2·0 | 9·7 | 1·71 | **3** |
| Under-Average | ... | | ... | **18·6** | 2·5 | **2·3** | **9·6** | **1·71** | 3 |

## 12th June.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches | Hours. |
| 1888 . | 013 | **9·0** | 001 | ... | **2·9** | **3·2** | **2·6** | 0·53 | **17** |
| 1889 . | 052 | 30·0 | 001 | ... | 1·1 | 6·3 | 44·7 | 5·86 | **72** |
| 1890 . | 025 | 3·0 | 003 | 2·0 | 0·8 | **3·5** | **13·8** | **2·33** | 31 |
| 1891 . | 026 | 4·0 | 001 | ... | 1·6 | 7·1 | 18·2 | 0·90 | **24** |
| 1892 . | 008 | **14·0** | ... | **1·0** | 1·5 | **4·6** | **19·3** | **1·57** | 57 |
| 1893 . | 024 | 2·0 | 001 | ... | **1·8** | 0·8 | **6·8** | **1·44** | **6** |
| 1894 . | 006 | **16·0** | ... | **1·0** | **0·2** | **2·6** | **20·3** | **1·96** | 30 |
| | 154 | 39·0 | 007 | 2·0 | 5·0 | 14·2 | 62·9 | **7·30** | **119** |
| Average | 022·0 | **39·0** | 001·0 | **2·0** | **4·9** | **13·9** | **62·8** | 7·29 | 118 |

SUMMARIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Evergreens— | | | | | | | | | |
| Over-Average . | | 39·0 | ... | ... | 1·7 | 10·7 | 42·3 | 2·99 | **71** |
| Under-Average | | **39·0** | ... | ... | **1·6** | **10·4** | **42·2** | **3·0** | 70 |
| Deciduous— | | | | | | | | | |
| Over-Average . | | ... | ... | 2·0 | **0·2** | 2·0 | 12·9 | 0·59 | **28** |
| Under-Average | | ... | ... | **2·0** | 0·3 | **1·7** | **12·8** | **0·60** | 27 |

## 12th July.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 017 | 3·0 | 004 | 2·9 | **0·9** | 3·1 | 21·7 | 1·68 | **56** |
| 1889 . | 026 | 12·0 | **002** | **3·1** | **1·5** | **0·4** | 10·7 | **0·53** | **14** |
| 1890 . | 011 | **3·0** | 001 | **0·1** | **1·3** | **2·4** | **4·8** | **0·49** | **10** |
| 1891 . | 009 | **5·0** | **001** | **2·1** | 3·4 | 3·3 | **15·8** | **0·17** | 18 |
| 1892 . | 008 | **6·0** | 009 | 7·9 | 2·0 | **1·7** | **7·8** | **1·11** | 40 |
| 1893 . | 010 | **4·0** | **003** | **4·1** | **2·1** | ... | **0·8** | 0·21 | **14** |
| 1894 . | 017 | 3·0 | ... | **1·1** | 0·7 | **2·0** | **3·3** | 0·40 | 33 |
| | 098 | 18·0 | 008 | 10·8 | 6·1 | **6·5** | **32·5** | **2·30** | **94** |
| Average | 014·0 | **18·0** | 001·1 | **10·5** | **5·8** | 6·4 | 32·4 | 2·29 | 91 |

SUMMARIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Evergreens— | | | | | | | | | |
| Over-Average . | | 18·0 | ... | ... | **1·7** | 0·7 | 29·1 | 1·55 | **37** |
| Under-Average | | **18·0** | ... | ... | 2·0 | **0·8** | **29·2** | **1·56** | **34** |
| Deciduous— | | | | | | | | | |
| Over-Average . | | ... | ... | 10·8 | 1·1 | 1·4 | 13·9 | 0·57 | **16** |
| Under-Average | | ... | ... | **10·5** | **0·8** | **1·5** | **14·0** | **0·58** | 13 |

## 12TH AUGUST.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 047 | 16·6 | ... | **1·4** | 3·7 | 4·9 | 5·6 | 0·48 | **19** |
| 1889 . | 044 | 13·6 | 001 | **0·4** | 1·2 | **0·6** | **7·9** | **0·23** | 9 |
| 1890 . | 014 | **16·4** | ... | **1·4** | 1·7 | 0·3 | 16·6 | 0·89 | **17** |
| 1891 . | 023 | **7·4** | 003 | 1·6 | **2·8** | **1·7** | 5·6 | 0·70 | 21 |
| 1892 . | 032 | 1·6 | **002** | **3·4** | 2·2 | 0·1 | **14·4** | **3·84** | 23 |
| 1893 . | 010 | **20·4** | **001** | **2·4** | **1·5** | **0·7** | **7·4** | **1·03** | 20 |
| 1894 . | 043 | 12·6 | 009 | 7·6 | **4·7** | **2·1** | 1·6 | 3·01 | **34** |
| | 213 | 44·4 | 010 | 9·2 | **9·0** | 5·3 | **29·7** | **5·10** | 73 |
| Average | 030·4 | **44·2** | 001·4 | **9·0** | 8·8 | **5·1** | 29·4 | 5·08 | **70** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 44·4 | ... | ... | 2·4 | 2·3 | **15·1** | **0·58** | **21** |
| Under-Average | | **44·2** | ... | ... | **2·6** | **2·1** | 14·8 | 0·56 | 24 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 9·2 | **7·5** | **3·8** | 7·2 | 3·71 | **13** |
| Under-Average | | ... | ... | **9·0** | 7·3 | 4·0 | **7·5** | **3·73** | 16 |

## 12TH SEPTEMBER.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 062 | 17·6 | 017 | 10·1 | 2·1 | 3·9 | 17·8 | 4·35 | **5** |
| 1889 . | 061 | 16·6 | 009 | 2·1 | **2·8** | **5·2** | **20·7** | **3·03** | **2** |
| 1890 . | 046 | 1·6 | 011 | 4·1 | 0·8 | **2·0** | **9·2** | **0·17** | 9 |
| 1891 . | 050 | 5·6 | 001 | **5·9** | **0·6** | 3·1 | 28·3 | 3·62 | 24 |
| 1892 . | 022 | **22·4** | 003 | **3·9** | 0·6 | **1·5** | **8·2** | **2·92** | 25 |
| 1893 . | 041 | **3·4** | 005 | **1·9** | ... | **0·1** | 4·8 | **0·16** | 14 |
| 1894 . | 029 | **15·4** | 002 | **4·9** | **0·3** | 2·0 | **12·7** | **1·69** | **68** |
| | 311 | 41·4 | 048 | **16·6** | **3·7** | 9·0 | 50·9 | 7·97 | **75** |
| Average | 044·4 | **41·2** | 006·9 | 16·3 | 3·5 | **8·8** | **50·8** | **7·97** | 72 |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 41·4 | ... | ... | **0·5** | **0·2** | 16·2 | 4·77 | 26 |
| Under-Average | | **41·2** | ... | ... | 0·3 | 0·4 | **16·1** | **4·77** | **29** |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 16·3 | 0·1 | **3·3** | **12·1** | 1·15 | 2 |
| Under-Average | | ... | ... | **16·6** | **0·3** | 3·5 | 12·2 | **1·15** | **5** |

## 12th October.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 051 | 1·4 | 038 | 15·4 | **5·3** | 1·2 | 7·4 | 1·79 | **81** |
| 1889 . | 091 | 41·4 | 037 | 14·4 | 0·7 | 0·4 | 1·9 | 2·08 | 3 |
| 1890 . | 048 | **1·6** | 010 | **12·6** | **2·3** | **4·8** | **16·6** | **2·79** | 43 |
| 1891 . | 046 | **3·6** | 028 | 5·4 | 2·4 | 2·3 | **8·6** | **2·46** | **63** |
| 1892 . | 028 | **21·6** | 018 | **4·6** | 6·4 | **1·3** | **9·6** | **2·24** | 71 |
| 1893 . | 026 | **23·6** | 011 | **11·6** | **4·3** | **2·9** | 5·9 | **1·69** | 28 |
| 1894 . | 057 | 7·4 | 016 | **6·6** | 2·2 | 5·3 | 19·4 | 5·28 | **3** |
| | 347 | **50·4** | 158 | **35·4** | **11·9** | 9·2 | **34·8** | **9·18** | **147** |
| Average | 049·6 | 50·2 | 022·6 | 35·2 | 11·7 | **9·0** | 34·6 | 9·15 | 145 |
| **SUMMARIES.** | | | | | | | | | |
| Evergreens— | | | | | | | | | |
| Over-Average . | 50·2 | ... | ... | | **2·4** | 6·9 | 28·7 | 9·15 | **81** |
| Under-Average | **50·4** | ... | ... | | 2·2 | **6·7** | **28·9** | **9·18** | 79 |
| Deciduous— | | | | | | | | | |
| Over-Average . | ... | ... | 35·2 | | **2·2** | 3·9 | 0·7 | 1·41 | **141** |
| Under-Average | ... | ... | **35·4** | | 2·0 | **3·7** | **0·9** | **1·44** | 139 |

## 12th November.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 055 | 19·4 | 074 | 25·1 | 1·8 | 5·8 | 3·5 | 0·47 | **77** |
| 1889 . | 038 | 2·4 | 053 | 4·1 | **0·8** | **3·8** | **9·7** | **1·27** | 21 |
| 1890 . | 034 | **1·6** | 050 | 1·1 | 4·1 | **3·3** | **8·2** | **2·08** | 24 |
| 1891 . | 025 | **10·6** | 054 | 5·1 | 0·9 | 2·4 | 13·8 | 2·90 | 1 |
| 1892 . | 032 | **3·6** | 027 | **21·9** | 1·4 | 2·1 | 3·3 | 1·59 | **45** |
| 1893 . | 030 | **5·6** | 039 | **9·9** | **5·3** | **0·3** | 6·3 | **0·29** | 21 |
| 1894 . | 035 | **0·6** | 045 | **3·9** | **1·9** | **3·1** | **9·2** | **1·35** | 55 |
| | 249 | **22·0** | 342 | **35·7** | 8·2 | **10·5** | **27·1** | **4·99** | 122 |
| Average | 035·6 | 21·8 | 048·9 | 35·4 | **8·0** | 10·3 | 26·9 | 4·96 | **122** |
| **SUMMARIES.** | | | | | | | | | |
| Evergreens— | | | | | | | | | |
| Over-Average . | 21·8 | ... | ... | | 1·0 | 2·0 | **6·2** | **0·80** | **56** |
| Under-Average | **22·0** | ... | ... | | **0·8** | **2·2** | 6·0 | 0·77 | 56 |
| Deciduous— | | | | | | | | | |
| Over-Average . | ... | ... | 35·4 | | 6·0 | 1·1 | **0·6** | 0·02 | **31** |
| Under-Average | ... | ... | **35·7** | | **5·8** | **1·3** | 0·4 | **0·05** | 31 |

## 12th DECEMBER.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 072 | 40·9 | 095 | 40·6 | **6·5** | **1·5** | 13·5 | 2·05 | **49** |
| 1889 . | 025 | **6·1** | 060 | 5·6 | **1·1** | **1·5** | 9·5 | 0·07 | ... |
| 1890 . | 032 | 0·9 | 049 | **5·4** | 3·7 | ... | **4·0** | 0·21 | **36** |
| 1891 . | 043 | 11·9 | 093 | 38·6 | **1·5** | 2·4 | **4·0** | 2·51 | 4 |
| 1892 . | 008 | **23·1** | 002 | **52·4** | 3·4 | **0·5** | **8·5** | **2·42** | 36 |
| 1893 . | **004** | **35·1** | 040 | **14·4** | 1·7 | 0·3 | **12·5** | **2·57** | 45 |
| 1894 . | 042 | 10·9 | 042 | **12·4** | 0·5 | 1·1 | 6·0 | 0·14 | 2 |
| | 218 | 64·6 | 381 | 84·8 | 9·3 | 3·8 | 29·0 | **4·99** | 87 |
| Average | 031·1 | **64·3** | 054·4 | **84·6** | **9·1** | **3·5** | **29·0** | 4·98 | **85** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 64·6 | ... | ... | **3·8** | 2·0 | 11·5 | 4·91 | **79** |
| Under-Average | | **64·3** | ... | ... | 4·0 | **1·7** | **11·5** | **4·92** | 81 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 84·8 | **9·1** | **0·6** | 19·0 | 4·63 | **45** |
| Under-Average | | ... | ... | **84·6** | 9·3 | 0·9 | **19·0** | **4·64** | 47 |

## 12th JANUARY.

| | Evergreens. | | Deciduous. | | Thermometers. | | Rain. | | Sun. |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Growth. | Plus or Minus Average | Measured Growth. | Plus or Minus Average | Max. | Min. | Hours. | Inches. | Hours. |
| 1888 . | 062 | 30·7 | 074 | 40·9 | **2·1** | 3·4 | 9·1 | 1·93 | **12** |
| 1889 . | 072 | 40·7 | 076 | 42·9 | **2·8** | 0·7 | 23·3 | 4·57 | **55** |
| 1890 . | 001 | **30·3** | 004 | **29·1** | 1·1 | **1·4** | **6·5** | **0·92** | **27** |
| 1891 . | 034 | 2·7 | 037 | 3·9 | **1·8** | **0·8** | **6·2** | **1·15** | **5** |
| 1892 . | 011 | **20·3** | **004** | **37·1** | 5·1 | **1·2** | **12·2** | **2·79** | 63 |
| 1893 . | 007 | **24·3** | 012 | **21·1** | 4·1 | 1·8 | **5·2** | **0·97** | 9 |
| 1894 . | 032 | 0·7 | 033 | **0·1** | **3·4** | **2·3** | **2·2** | **0·69** | 25 |
| | 219 | **74·9** | 232 | 87·7 | 10·3 | 5·9 | 32·4 | **6·52** | **99** |
| Average | 031·3 | 74·8 | 033·1 | **87·4** | **10·1** | **5·7** | **32·3** | 6·50 | **97** |
| SUMMARIES. | | | | | | | | | |
| EVERGREENS— | | | | | | | | | |
| Over-Average . | | 74·8 | ... | ... | **10·1** | 1·0 | 24·0 | 4·66 | **47** |
| Under-Average | | **74·9** | ... | ... | 10·3 | **0·8** | **23·9** | **4·68** | 45 |
| DECIDUOUS— | | | | | | | | | |
| Over-Average . | | ... | ... | 87·7 | **6·7** | 3·3 | 26·2 | 5·35 | **72** |
| Under-Average | | ... | ... | **87·4** | 6·9 | **3·1** | **26·1** | **5·37** | 70 |

# TRANSACTIONS AND PROCEEDINGS

OF THE

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# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH.

## SESSION LXVI.

### PRESIDENTIAL ADDRESS.—THE EUROPEAN SPECIES OF THE GENUS PRIMULA. By Rev. DAVID PAUL, LL.D., Edinburgh.

(Delivered 14th November 1901.)

There is no group of plants that surpass in elegance and beauty those of the order of Primulaceæ, comprising the genera Primula, Soldanella, Androsace, Anagallis, and others. The species are not only beautiful without exception, but they possess a neatness and modesty and grace which specially endear them to all lovers of nature. They are peculiarly interesting also to the cultivator of plants, as they respond well to care and attention, while they require just enough horticultural knowledge and skill to render the successful cultivation of them an attractive pursuit. I propose, therefore, to make some observations on the genus Primula, the most important genus in the order.

The species of Primulæ are found in all the temperate regions of the northern hemisphere. They are very poorly represented, however, in America. On the Atlantic side of the continent *P. farinosa*, L., alone occurs, extending southwards hardly beyond the border of Canada. Six species occur on the Pacific side, in the Rocky Mountains, viz.

*P. farinosa*, L.; *P. Rusbyi*, Greene; *P. angustifolia*, Torr.; *P. Cusickiana*, A. Gray; *P. suffrutescens*, A. Gray; *P. Parryi*, A. Gray. In the old world there is a great variety of species. Europe possesses in all thirty-one, scattered over the British Isles, Scandinavia, Finland, Russia, the Pyrenees, Alps, Austria, Italy, Bulgaria, and Thrace. But by far the greater number of species is to be found in Asia, especially in the Eastern Himalayas, but also in Afghanistan, Thibet, China, Japan, and elsewhere. The well-known *P. sinensis*, Lindl., and *obconica*, Hance, are natives of China; *P. Sieboldi*, Morren, and *P. Japonica*, Gray, are from Japan; *P. floribunda*, Wall., from Afghanistan; *P. verticillata*, Forsk., from Arabia and Abyssinia; *P. luteola*, Rupr., from the Eastern Caucasus; *P. rosea*, Royle, from the Western Himalayas; *P. capitata* and *P. Sikkimensis*, Hook., from Sikkim; *P. denticulata*, Sm., and *P. involucrata*, Wall., from Cashmere. I mention these as being all well-known, cultivated plants in this country. A large number seem not yet to be grown by our horticulturists.

Turning, however, to the Primulæ of Europe, I proceed to enumerate them (omitting for the present the hybrids), describing the greater number, and making any remarks on the different species that may seem to be called for.

They may be grouped under three sections, or subgenera, of which *P. auricula*, L., *P. farinosa*, L., and *P. officinalis*, L., may be taken as the respective types.

I. The first section, that of **Auricula,** is marked by the leaves being involute in the young state, by the flowers being almost always umbellate, and by the short, globose or oval capsule. The only other group of Primulæ with involute leaves is a small foreign group consisting of *P. floribunda*, Wall.; *P. verticillata*, Forsk.; and *P. Aucheri*, Jaub. and Spach.

The twenty-two species of this section are exclusively European. No species occur either in America or in Asia. Moreover, in Europe they are confined to the southern mountain ranges, and they are most of all to be found in the Eastern Alps. Three only—*P. integrifolia*, L., *P. viscosa*, All., and *P. hirsuta*, All.—occur in the Pyrenees;

one—*P. Palinuri*, Pet.—is found in the neighbourhood of Naples; while three—*P. minima*, L., *P. clusiana*, Tsch., and *P. auricula*, L.—travel as far east as the Carpathians. Their chief home is the Tyrol and Carinthia. They do not occur in the north of Europe.

*A.* The section *Auricula* has been divided by Schott into different groups of species. The first of these is that of *Auricula* proper, or EUAURICULA, with yellow, or violet, heterostyle flowers; a short calyx; a corolla marked with a zone of farina near its base; short, broad, involucral bracts; farinose leaves bearing glandular hairs; and a short, globose or oval capsule.

1. P. AURICULA, L.—Very widely distributed over the Swiss and Austrian Alps; also in the Pyrenees, Jura, Apennines, Carpathians. Leaves quite entire, or repand-denticulate; leaves, calyx, and flowers white-farinose; flowers yellow, fragrant. There is a well-marked variety (*albocincta*) with comparatively little farina on the surface of the leaves, which, however, have a conspicuous, white, farinaceous border. This seemed to be the prevailing form in the neighbourhood of Val Daone. Another variety (*nuda*), which occurs in the Dolomite district, has farina only on the calyx. Still another variety (*monacensis*), found sparingly on the Alps, but in greater quantity in the neighbourhood of Munich, is distinguished by its very broad leaf-stalk and its narrow spread of leaf.

P. BALBISII, Lehm., is a sub-species of *P. auricula*, L., in which the green parts of the plant are destitute of farina, and the gland-bearing hairs are longer, being dense on the margins of the leaves, but occurring more sparingly on their surface. The colour of the flowers is a darker yellow, not so bright as in *P. auricula*, and they are without scent. This is *P. ciliata*, of Moretti.

2. P. PALINURI, Pet., is the only other yellow *Auricula*. It occurs in the neighbourhood of Cape Palinurus, in Italy. Apart from its being, in general, a larger plant, its main difference from *P. auricula* lies in the fact that, instead of the cartilaginous leaf-border and short sepals of the latter, the leaves are only cartilaginous at the points of the teeth, and the sepals are large and leaf-like.

3. P. MARGINATA, Curt.—This Primula occurs only in Dauphiny and the south of Piedmont, and in the Maritime and Cottian Alps. Not found in Switzerland. Leaves bluntly dentate, with a remarkable margin of white farina; calyx farinose. Flowers lilac-blue, passing sometimes almost into rose; throat of corolla generally of same colour.

4. P. CARNIOLICA, Jacquin.—Found apparently only in the mountains about Idria, in Carniola. Leaves nearly entire, without farinaceous border; calyx and corolla without farina. Flowers rose or lilac; throat of same colour.

*B.* Passing from the group *Euauricula*, and continuing to adopt the division of Schott, I take up next those *Primulæ* which he groups under the term ARTHRITICA, of which the characteristic marks are that the leaves are quite entire, surrounded by a distinct cartilaginous border; the involucral bracts elongated and narrow; the flowers shortly pedunculate, or subsessile, and of a rosy violet colour; the segments of the bifid, obcordate corolla hairy, but without farina at the throat; and the calyx long. Outer covering of the seeds plane.

In this group there are six species.

5. P. CALYCINA, Duby, = P. GLAUCESCENS, Moretti.—This plant occurs in the north of Lombardy, from the Lake of Como to district of Judicaria. The leaves are not punctate, and quite glabrous on the upper surface; the cartilaginous margin is very broad and somewhat eroded; they are lanceolate or elliptic-lanceolate; glaucescent; with an acute apex, Involucral bracts, linear, acute, long. Flowers rosy, purple, or lilac.

There is a variety, *longobarda*, Porta, which is smaller, with a shorter, blunt-toothed calyx, and smaller flowers. Pax regards this as an intermediate form between *P. spectabilis*, Tratt., and *P. calycina*. Widmer holds it to be simply a form of *calycina*.

6. P. CLUSIANA, Tausch. — Found, on limestone, in Eastern Bavaria, Salzburg, Upper and Lower Austria, and north of Styria. Leaves not punctate, with a narrow cartilaginous border; bright green; oval or oblong-oval;

apex rounded, obtuse, or acute. Involucral bracts generally longer than the peduncles. Calyx teeth oval, blunt, somewhat distant from the corolla-tube. Capsule half the length of the calyx. Flowers rosy.

*P. admontensis*, a plant found by Gusmus sparingly at Admont, in Styria, among *P. clusiana*, differs from the latter only in the leaves being toothed from the middle upwards—the teeth small, distant, blunt, fourteen or sixteen on a leaf. Widmer regards this plant as arising from the repeated crossing of some *clusiana* hybrid with *P. clusiana*, and thinks that *clusiana* hybrid may be either *P. auricula* × *clusiana*, *P. clusiana* × *villosa*, or *P. clusiana* × *minima*. *P. Churchillii* seems to be much the same plant.

7. P. WULFENIANA, Schott.—Occurs on limestone, on the Alps of Venetia, Carinthia, and Carniola. Leaves very stiff, dark blue-green, not punctate, with broad, whitish, cartilaginous margin, glaucescent, elliptic or oblong, with acute apex, glabrous; their margin, as also the calyx, beset with minute glandular hairs. Involucral bracts generally longer than the peduncles; teeth of the long calyx obtuse, and adpressed to tube of corolla; capsule shorter than calyx; flowers rosy lilac.

8. P. SPECTABILIS, Tratt.—On limestone, Alps of Bergamo and of the Southern Tyrol. Leaves *pellucid-punctate*, with broad cartilaginous border, viscid. Flowers rosy red, passing into violet; throat whitish. Easily identified by the pitted, sticky leaves.

9. P. INTEGRIFOLIA, L.—Pyrenees, Switzerland, Tyrol. Not in Dauphiny, Savoy, or Piedmont. Leaves soft, bright-green, shining, *without cartilaginous margin*, very entire, elliptic or oblong, somewhat viscid, sparsely covered with long, glandular, articulate hairs. Calyx teeth obtuse or rounded; involucral bracts rarely reaching the top of the calyx; capsule shorter than the calyx. Flowers dark rosy-lilac; throat of the same colour.

10. P. KITAIBELIANA, Shott.—Found in Croatia, on limestone; Servia; Herzegowina. Leaves somewhat glaucescent, fragrant, *without cartilaginous border*, large, elliptic-oval or oblong-lanceolate, entire, or denticulate on the upper half; green parts of the plant more or less viscid, beset with

short glandular hairs; involucral bracts about reaching base of calyx; capsule half the length of calyx; flowers rosy, with whitish throat which is covered with longish glandular hairs.

These two last Primulas do not properly belong to the group *Arthritica*, being destitute of cartilaginous border.

*C.* The next group comprises six Primulas, and is named by Schott ERYTHRODROSUM. Its characters are—leaves fatty, dentate-serrate or serrulate, without cartilaginous border, densely covered with hairs, which exude a red gum, veins immersed. Involucral bracts short, flowers peduncled, red or white, not yellow, calyx longish.

11. P. HIRSUTA, All., = P. VISCOSA, Vill.—Pyrenees and Alps; very widely distributed. Leaves obovate or rounded-obovate, more or less toothed along the whole margin; capsule shorter than the calyx.

Of this Primula there are four varieties—(1) *P. ciliata*, Schrank, in which the teeth of the leaves are equal, and the margin is white and densely glandulose; (2) *P. pallida*, Schott, with unequal teeth, pale lilac blooms and cuneate, obovate flower-tips; (3) *P. confinis*, Schott, with very fleshy, extended leaves, thickly covered with brown glandular hairs, broad corolla-tips, and very short calyx teeth; (4) *P. excapa*, Heg., with sessile leaves, whose teeth are cut in the form of an arch, and with almost stemless flowers, which sit on the rosette of leaves, and are together almost larger than the whole plant. This variety occurs at very high altitudes. There is also a variety with white flowers, which is the so-called *P. nivalis* of gardens.

12. P. ŒNENSIS, Thom.—Found on the Alps of the southern and western Tyrol, and of eastern Switzerland; Ortler, Val Muranza, Val Daone, Val Venosta, etc. This is the smallest of the group, though other species may be found as small, when they grow in poor, dry situations, or at high altitudes. Its small, cuneate, and truncate leaves are found among none of the allied Primulas; but to make sure of correct identification, it is well to note the character of the hairs on the very viscid leaf, which are thick and short and bear large reddish yellow or dark red glands, the calyx pressed close to the corolla tube, the short peduncles,

and the capsule a little longer than the calyx. I could find only a few specimens of this plant on the mountains bordering the Val Daone.—Syn. *P. daonensis*, Leybold.

The var. *Judicariæ* is a somewhat larger plant with cuneate leaves, coarsely toothed towards the apex, the middle tooth longer and somewhat larger than the rest.

13. P. VISCOSA, All.—There is much confusion in the nomenclature of this Primula. Kerner and Pax retain Allioni's name. Widmer adopts the name of Lapeyrouse, P. LATIFOLIA, objecting to the name *viscosa* as unsuitable, the plant not being particularly viscid; and he rejects Villar's name of P. HIRSUTA to avoid confusion with another species, and as not being specially characteristic. Hegetschweiler calls it P. GRAVEOLENS. I retain the name by which the plant is best known.

Found widely distributed from the Pyrenees through the chain of the Alps to the 10th degree of E. Longitude. Not common on the Pyrenees or Western Alps. On granite.

Leaves somewhat flaccid, fragrant, without cartilaginous margin, oval, round-oval, oblong-cuneate or lanceolate-cuneate, gradually narrowed into a generally long petiole, from about the middle to the apex acutely-dentate or repand-denticulate, or quite entire, the surface and margin somewhat densely clothed with short glandulose hairs. Glands small, colourless, not reddening the drying paper. Peduncles generally long. Calyx teeth adpressed to tube of corolla. Flowers secund, nodding, violet or reddish violet, throat and interior of tube of same colour. Corolla infundibuliform. Farina rare on the throat of corolla, and very sparingly on the calyx. Anthers of the short-styled flowers set on the throat or a little below it. Capsule hardly or considerably longer than the calyx.

The scent is peculiar, and stronger than in other Primulas. It has been compared to the smell of bitumen, or of *Geranium robertianum*, or of weak musk.

The plants with the leaves quite entire (in form very similar to those of *Cynoglossum vulgare*) are from the Maritime Alps. Their flowers are somewhat brighter in colour.

14. P. PEDEMONTANA, Thom.—Occurs in Piedmont and

Savoy; not in Switzerland. Leaves obovate or oblong-lanceolate, narrowed gradually—more rarely suddenly—into the petiole, quite entire, or repand-dentate, more rarely distinctly dentate, surface almost glabrous, margin thickly beset with very short glandular hairs. Glands somewhat large, cinnabar-coloured, or more rarely purple. Calyx teeth somewhat appressed. Capsule same length as calyx. Flowers dark rose, seldom pale rose, rarely white; inner portion of corolla mostly pure white.

To be distinguished from the other Primulas that have coloured glands, by the almost shining leaves with red margins and very shortly stipitate glands.

15. P. APENNINA, Widm. In the northern Apennines: Mte. Orsajo.—Leaves oblong or oval, entire, or dentate towards the apex; teeth small, approximate, the surface and margin beset with short glandular hairs; glands somewhat large, purple. Scape a little longer than, or twice as long as, the leaves. Peduncles very short, calyx teeth sub-adpressed to the corolla tube. Capsule one-fifth or one-sixth shorter than the calyx.

This description by Widmer is taken from specimens in fruit; he does not give the colour of the flowers.

His remarks are: *P. apennina* has the habit of a *P. pedemontana* grown on poor soil, from which it differs in the more copious covering of hair on the leaf surface, but sparser border of hair on the margin (the margin is not red), and further in the calyx being longer in proportion to the capsule. From *P. œnensis*, *P. villosa*, and *P. cottia*, it is distinguished by the covering of hair being not so thick, and shorter, and by the longer capsule. From *P. hirsuta*, All., with which it agrees in the calyx, it is separated by the much shorter and less thickly-set hairs, by the longer flower stalk, the shorter peduncles, and also by its habit.

16. P. COTTIA, Widm.—In Piedmont, Cottian Alps, at an altitude of 3000–6500 feet: Val Germanasco, Valleys of Clusone and Von Oulx.

This Primula is very similar to *P. villosa*, especially to the form from Rennfeld, but differs in the shorter capsule, in the proportionately longer calyx, and somewhat thinner leaves. It is marked off from the sub. sp. *commutata* by

the longer and closer-set hairs, as also by the somewhat broader leaves, which have shorter petioles, and are less bluntly toothed, while the comparative length of capsule and calyx is nearly the same.

Widmer remarks that he does not venture to join it as a variety to *P. villosa* and *P. commutata*, to which it approaches nearest in habit and other characters, because the localities in which it is found are separated from the home of the latter by a wide tract of country yielding distinct species (*P. hirsuta*, All., and *P. œnensis*). He is of opinion that it is more intimately connected with *P. hirsuta*, All., from which it differs in its longer flower stalk, in the leaves more gradually narrowed into the petiole, in its longer hairs which have less highly coloured glands, in its shorter peduncles, in its calyx teeth closer to the tube of the corolla, and in its capsule being longer as compared with the calyx.

The colour of the flowers of *P. villosa*, *P. commutata*, *P. cottia*, and *P. hirsuta*, All., is very much the same.

17. P. VILLOSA, Jacquin.—On the Alps of Styria, Carinthia, and Carniola—on granite. Leaves obovate or oblong, gradually narrowed into the shortish petiole, more rarely almost suddenly contracted, apex obtuse or rounded, more rarely sub-truncate, toothed from the middle or only near the apex, with small close teeth, sometimes quite entire, the surface and margin somewhat densely covered with longish glandular hairs; glands small, red; peduncles short; capsule generally a little longer than the calyx; flowers lilac or rose; inner part of corolla mostly pure white.

Closely allied to *P. œnensis*.—The variety *norica* of Kerner is the smaller leaved form, with the hairs shorter, and not so thickly distributed. The leaves are generally narrow and truncate.

Sub-sp. P. COMMUTATA, Schott, is distinguished by thinner leaves, the blade and stalk of which are longer, by larger, more distant teeth, a somewhat longer calyx, and somewhat shorter capsule. These points are not constant enough to mark a distinct species.

*D.* The next two species form a group to which Schott gives the name RHOPSIDIUM. The leaves are fleshy, with

cartilaginous teeth, and are surrounded by a very narrow, indistinct, cartilaginous border, and densely clothed with hairs, which exude colourless viscid matter. Involucral bracts narrow, elongated. Flowers subsessile, more or less violet; calyx of moderate length; corolla lobes bifid, and glandular-hairy; the throat with glandular hairs and coloured folds reaching to the partition of the lobes.

18. P. Allionii, Loisl.—Scattered over a small region between Cuneo and Nice, in the Maritime Alps — on limestone.

Leaves somewhat fleshy, very viscid, grey-green, almost scentless, roundish or oblong, entire or toothed. Green parts of the plant without farina, very densely covered with glandular hairs; glands colourless; flower stem scarcely one mm. long; peduncles two to four mm. long; calyx teeth adpressed. Flowers rosy, throat white and beset with short glandular hairs; anthers of the short-styled flowers distant from the throat by one-fifth of the length of the tube; capsule generally shorter than the calyx.

In cultivation, this interesting Primula must be grown in the shade and protected from rain. In its native habitats the root-stock is covered with the withered leaves of former years still adhering and imbricated over it like roof tiles.

19. P. tyrolensis, Schott.—South Tyrol and Venetia—on limestone rocks and stony turf. Leaves somewhat fleshy, viscid, dark green, with little scent, small, roundish or oblong, almost entire or denticulate, teeth with cartilaginous tips. Green parts of the plant densely beset with short glandular hairs; glands colourless. Flower stem four-tenths to two cm. long, one to two flowered; peduncles almost none. Involucral bracts lanceolate or linear, reaching generally half-way up the calyx or to its top. Calyx teeth leaning on the tube of the corolla. Flowers rosy lilac, throat whitish and covered with longish glandular hairs. Anthers of the short-styled flowers inserted a little below, or one-fourth of the tube below, the throat. Capsule reaching a little above the middle of the calyx.—Syn. *P. Allionii*, Koch.

Differs from *P. Allionii*, Schott, in the cartilaginous tips of the leaf-teeth, in the short peduncles, in the long

narrow involucres, in the calyx teeth broadening towards the top, in the shorter and less thick clothing of hair, in the more deeply-cut corolla lobes, in the capsule shorter in proportion to the calyx, and in the smooth, not papillose, epidermis of the seeds. When the plant grows on rocks, the root stock is covered with withered leaves, as in *P. Allionii.*

*E.* Cyanopis, Schott.—This group contains one species.

20. P. glutinosa, Wulf.—Found in Lower Engadine, N. and S. Tyrol, Carinthia, Styria, Carniola, Salzburgh, N.-E. Italy—on schist. Leaves somewhat fleshy, glutinous, hardly shining, with something of a cartilaginous margin towards the apex, punctate on the surface, lanceolate-cuneate or oblong-lanceolate, with obtuse or rounded apex, margin rarely entire, generally denticulate, with seven to nine teeth. Involucral bracts oval, rounded at the apex, equal to or overtopping the calyx. Calyx brownish red, teeth oval, obtuse, adpressed to the corolla tube. Flowers very fragrant, at first dark blue, later violet, very seldom white, with a dark ring above the throat. Anthers of the short-styled flowers inserted in, or beneath, the throat. Capsule a little shorter than the calyx.

I have never seen a more beautiful sight than a large bed of this Primula on the Muttenjoch, in the Gschnitzthal, in full flower, and exquisitely fragrant in the fresh breeze blowing over the summit of the Pass.

*F.* Chamæcallis, Schott.—This group also contains only one species, P. minima, with its hybrids. Its characters are—Leaves fleshy-coriaceous, smooth, glabrous, with the exception of the capitate hairs, more rarely sub-hirsute or sub-villous, with somewhat cartilaginous points, and with hardly any distinct cartilaginous border. Involucral bracts elongated, narrow. Flowers subsessile, rosy or white. Calyx somewhat long. Lobes of corolla bifid or deeply emarginate, obcordate, hairy towards the villous throat, which is destitute of folds. Outer covering of seeds plane.

21. P. minima, L.—Found on the Eastern Alps and mountains of eastern Europe. Not in Switzerland. On schist, granite.

Leaves stiffish, shining, without cartilaginous border, cuneate or obtriangular, apex truncate, more rarely arcuate, furnished with three to nine acuminate-mucronate teeth, glabrous, the margin of the leaves and the superior green parts of the plant sprinkled with minute glandular hairs. Flower-stalk short, rarely as long as the leaves, one to two flowered. Peduncles almost none, or as long as 3 mm. Involucral bracts lanceolate, generally a little shorter than the calyx, the apex acuminate or somewhat mucronate. Calyx green, 6 to 9 mm. long, with mucronate teeth. Flowers rosy; throat and interior of corolla-tube glandular-villous, white. Limb of the corolla broad, plane behind, clearly distinct from the tube; its radius 7–16 mm. long. Lobes of the corolla obcordate, bifid, cut from two-fifths to half its length. Anthers of the short-styled flowers generally set on the middle of the tube. Capsule hardly reaching half way up the calyx.

Widmer's description is here given in full, as this Primula is often difficult to distinguish from some of its hybrids. With regard to the teeth at the apex of the leaves, he remarks that, after a careful examination of a great number of plants from different districts, the following four groups can be made out:—

In No. 1 all the teeth are of the same size and height.

In No. 2 the two, three, or four middle teeth are equal in size and height, while those at the sides are not so high, and are often also smaller.

In No. 3 all the teeth are pretty much of one size, but are set on an arched line, so that the middle one is somewhat higher than the others.

In No. 4 all the teeth form an arched line, the middle one is the largest and highest, while the rest decrease in size on both sides of it, so that the outermost ones may be much smaller than the central one.

22. P. DEORUM, Vel.—On Mount Rilo, in Bulgaria, in moist, grassy spots beneath the snowfields, at an elevation of 8000 feet. On syenite.

Leaves slightly fleshy, rather coriaceous, stiff, with a distinct cartilaginous border, punctate on the upper side (the points, not translucent, dark in reflected light, being little shallow pits); oblong or lanceolate, with acute apex;

very entire, with extremely small, almost stalkless, glands set on the pits of the upper surface. Flower stem, bracts, and calyx remarkably black and viscid. Flower stem three or four times longer than the leaves, with five to ten flowers. Peduncles 2 to 5 mm. long. Involucral bracts oblong-linear, often reaching the top of the calyx. Calyx 3 to 4 mm. long, cut to the middle; the teeth narrowly triangular, acuminate. Flowers secund, nodding, red violet; throat and interior of corolla tube of the same colour. Tube passing gradually into the infundibuliform corolla. Radius of corolla 6 to 7 mm. long. Divisions of corolla cut to one-fifth of their length. Anthers of short-styled flowers set a quarter of the length of the tube beneath the throat. Capsule (immature) included in the calyx.

Discovered by Velenovsky in 1889. The above is mainly his description. Widmer says: "*P. deorum* resembles in the colour of its flowers, and in habit, a diminutive, small-leaved *P. latifolia* (*P. viscosa*, All.). It is certainly a beautiful Primula, but I would much rather give the name Primula of the Gods to one of the Alpine species with numerous large bright flowers, as *P. pedemontana*, from Mount Cenis; *P. viscosa* (*P. hirsuta*, All.), from Faido and Aosta; *P. calycina*, from Corni di Canzo; *P. spectabilis*, from the Ledrothal." But Widmer had never seen the living plant.

II. Section **Farinosæ.**—Leaves revolute, petioled or sessile, often narrowed into a winged petiole, membranaceous, with or without farina, toothed or quite entire; flowers of middling size or smaller, oftenest blue, or rosy or white, very rarely yellow; bracts more or less lanceolate or subulate, gibbous at the base, or distended towards the base; capsule cylindrical.

23. P. SIBIRICA, Jacq.—Occurs in Finland and the north of Sweden and Norway. Leaves roundish or oval, suddenly contracted into the petiole; involucral bracts oval or oblong, acute or shortly acuminate, very gibbous at the base; farina none; calyx cylindrical; flowers somewhat large, less numerous than in the next species, pale lilac; segments of corolla cut to one-third or one-half their length.

The only well-marked variety is P. EGALLICENSIS, Wormsk. and Lehm., found in Greenland and Labrador, which, however, Pax regards as a distinct species.

24. P. FARINOSA, L.—Found all over Europe, except in the most southerly parts. Small, commonly 10 to 20 cm. high, rarely taller; leaves obovate-oblong or oblong, gradually narrowed into the petiole, white-farinaceous beneath, denticulate or nearly entire; scape much longer than the leaves; flowers shortly pedicellate, flesh-coloured then lilac, more rarely purple or white; calyx teeth sub-obtuse, triangular; corolla tube much longer than the calyx.

*P. Warei*, Stein, differs somewhat from the type in its leaves, which are regularly crenulate-denticulate, and in its dark violet flowers.

Var. *lepida*, Duby, differs from the type only in being destitute of farina. It appears not to have been found in recent times on the north side of the chain of Alps.

Var. *exigua*, Velen., has its seeds pale instead of dark brown, as in *P. farinosa*. The leaves in the young state are on the under side sometimes quite covered with thinly spread farina, which, however, disappears more or less later; sometimes it is altogether destitute of farina. Calyx teeth acuminate. The plant is barely 12 cm. high.—From Bulgaria.

25. P. SCOTICA, Hook.—In north of Scotland and in Orkney. The distinguishing marks of this species, as compared with *P. farinosa*, are broad, rounded calyx teeth; broad elliptical leaves, equally and finely cut on the margin; a short scape; and dark violet flowers. Pax regards this as a true species, but he holds *P. Scotica*, Blytt, the Scandinavian plant, to be a form of *farinosa*.

Widmer remarks that the broad, rounded calyx teeth are not found in all the Scottish specimens, and further that they occur in occasional specimens of *farinosa* from widely different localities. As to the colour of the flowers, he regards the dark violet colour as only a dark red, just as the dark violet of *P. Warei*, Stein, is really in the living plant a beautiful, intense red. Accordingly he does not separate *Scotica* from *farinosa*.

26. P. STRICTA, Hornem.—In northern Scandinavia,

northern Russia, and Finland. Green parts of the plant not farinose, with the exception of the inner surface of the calyx. Calyx more or less ventricose. Flowers small, less numerous than in *farinosa*. Lobes of the corolla slightly emarginate.

Pax, with some hesitation, regards this as a species. Widmer thinks it is not specifically distinguished from *P. farinosa*.

27. P. LONGIFLORA, All. — Switzerland, north Italy, north and south Tyrol, Styria, Carinthia, Carniola, Hungary, Bosnia, and Montenegro. Leaves obovate-oblong or oblong, gradually narrowed into the petiole. Farina abundant on the lower side of the leaves, on the upper part of the scape, and lower part of the calyx. Calyx cylindrical, teeth lanceolate. Flowers less numerous than in *P. farinosa*, paler or darker red-violet, throat yellow; corolla tube of a dirty red, or, especially in the upper part, yellowish, 20 mm. long or longer, seldom only 16 mm. long, two to three and a half times as long as the calyx. Homostyle plants, the anthers of all the flowers being set in the throat of the corolla; stigma protruding.

This species appears to be very constant, and subject to very little variation. Very rarely the leaves are without powder on the under side.

28. P. FRONDOSA, Janka.—Found in the north of Thrace. Leaves thin, oval or lanceolate-linear, generally furnished with copious farina beneath. Involucral bracts linear-lanceolate, not gibbous at the base. Calyx ovate-cylindrical. Flowers of the same size as in *P. farinosa*.

III. Section **Vernales.**—To this section, identical with the sub-genus *Primulastrum* of Duby, belong the remaining European Primulas.

Leaves revolute when young, membraceous, rugose, more or less pubescent, without farina, undivided, serrulate or denticulate or crenulate. Flowers yellow or purplish, umbellate; scape elongate or almost wanting. Involucral bracts narrow, not gibbous. Calyx tubular or campanulate, with sharp angles and acute segments. Capsule cylindrical, exserted or included in the calyx. Stomata of the upper

surface of the leaves few, those of the under surface numerous.

Found over the whole of Europe, with the exception of the sub-arctic region, from the sea-level to an elevation of 6500 feet. They occur also in the district of the Eastern Mediterranean. *Primula acaulis* is found in Algeria, and *P. elatior* and *P. officinalis* in Siberia.

29. PRIMULA ACAULIS, L.—Flower scape wanting. Peduncles long, arising from the root-stock. Leaves more or less hairy beneath. Corolla flat, large, pale sulphur colour. Capsule oval, two-thirds as long as the calyx. *P. vulgaris*, Huds.—Occurs throughout almost the whole of Europe.

Var. *caulescens*, Auct., differs from the type in having a developed flower scape, and is found rarely with the ordinary form.

Var. *balearica*, Willkomm.—Leaves on the underside almost glabrous. Flowers white. Balearic Islands.

Var. *Sibthorpii*, Reichenb.—Leaves more or less hairy beneath. Scape almost wanting. Flowers rosy. Eastern Mediterranean region.

30. P. ELATIOR, L.—Flowers umbellate on a scape. Leaves more or less pubescent beneath, or glabrous. Corolla tolerably large, sulphur-coloured, nearly flat. Capsule cylindrical, a little longer than the calyx. Leaves oval or obovate, much wrinkled, generally contracted suddenly into the more or less winged petiole. Calyx with acute triangular teeth; angles green.

Almost everywhere in Europe, from the sea-level to an altitude of nearly seven thousand feet (in Bavaria and the Tyrol).

Var. *intricata*, Gr. Godr.—Leaves obovate-elliptical or oval, gradually attenuated into the broadly-winged petiole, less wrinkled. Scape a little longer than, or shorter than, the leaves. Calyx narrowly tubular-campanulate, with triangular, acute segments. Capsule shortly cylindrical, equalling the calyx, or more rarely a little longer.

Pyrenees, Alps, Bosnia.

31. P. OFFICINALIS, L.—Flowers umbellate, two to forty on the scape. Leaves ovate or ovate-oblong, generally contracted suddenly into the winged petiole;

velvety and grey-green beneath. Calyx campanulate, inflated, whitish yellow; teeth broadly ovate or triangular, shortly acuminate. Corolla small, concave, egg yellow, less commonly sulphur yellow. Capsule oval, only half as long as the calyx.

Almost everywhere throughout Europe, reaching to an altitude of 4000 feet.

Var. *Pannonica*, Kerner.—Leaves oval or oblong, generally contracted gradually into the winged petiole, underneath hoary-tomentose. Calyx widely campanulate. This is var. *inflata*, Pax.

Hungary, Lower Austria, Maritime Alps, Pyrenees, etc.

Var. (sub. sp.?) *Columnæ* (Ten.) Pax.—Leaves ovate or cordate, suddenly narrowed into the narrowly winged petiole, underneath snowy-tomentose, thickly felted. Corolla, as in var. *Pannonica*, somewhat flatter than in the type.

Found over the whole Mediterranean region.

Var. *Tommasinii*, Gr. Godr.—Corolla sulphur yellow (as in *P. elatior*), with five orange spots, almost flat, otherwise like *P. Columnæ*.—Mte. Maggiore, near Fiume, and Pic de l'Hiéris in the Pyrenees.

The four forms, *officinalis*, *Pannonica*, *Columnæ*, and *Tommasinii*, pass imperceptibly into one another, so that many plants may be equally well referred to one or to another of them. Kerner regards the most distinct difference to lie in the form and size of the corolla; he unites *Columnæ* with *Tommasinii*. These two can be distinguished only by the flowers, which in the former are bell-shaped and egg yellow, as in *P. officinalis*, while in the latter they are flat, or almost flat, and sulphur-coloured, as in *P. elatior*.

*Note*.—In compiling this account of the European Primulæ, I am specially indebted to two works which I have used freely, viz. "Monographische Uebersicht über die Arten der Gattung Primula," von Dr. Ferdinand Pax, Leipzig, 1888, and "Die europäischen Arten der Gattung Primula," von E. Widmer, München, 1891.

## Notes on Recent Experiences with Dry-Rot.

By Dr. James Hunter, F.R.S.E.

(Read 12th December 1901.)

It is not to be understood that the present brief paper is given as an intended addition to the already voluminous technical descriptions of the biological characters of either the *Merulius*, the *Telephora*, or any of the fungi already so well known to be connected with the peculiar form of decay in timber generally called dry-rot. Neither is it my present purpose to recount, even in epitome, a selection of the various "cures" for this pest, which have, at one time or other, been suggested by either those who consider themselves best qualified, as so-called "scientists," or as so-called "practical men," connected with buildings, etc., to deal with this matter.

Till but recently, I must confess, my own interest in this subject was merely academical, having simply made myself acquainted with some of the fungi in question for purely educational purposes. I may, however, mention that for some months past my attention has been drawn to by no means trifling "outbreaks"—if one may call them so—of dry-rot in my neighbourhood, some of which have been the cause of very considerable loss, so that my microscopical acquaintance with *Merulius* became renewed. With this I should have, possibly, been contented, so far as scientific interest went, but, as it turned out, circumstances so arranged themselves as to furnish me with the rather questionable convenience of a home-study of this interesting subject. Fortunately the occurrence of the destructive agency in question was confined to a piece of timber of a structure standing in my garden at a considerable distance from the house I occupy. Perhaps it might be said that—instead of retaining that single beam in its place (though the process of decay was ostensibly limited to but a very small portion of it) and attempting, as I did, any means to destroy the vitality of the attacking fungus by way of experiment or otherwise—my best plan would have been to remove at once the faulty piece of wood entirely.

In effect I practically did so, by so isolating it that no contiguous piece could become affected by direct contact during the time I have allowed it to remain for the sake of experiment. Had the structure been part of a valuable building I should, no doubt, have acted otherwise The affected beam being however one of a few newly added parts, while the older parts were very hard, sound, and well protected with paint, the experiments were, under the circumstances, so far excusable.

They were these—The mycelia of the fungus, which showed only the white cottony filaments forming the early stage of the "pileus" were, as tested by cutting, confined to quite a superficial layer along one edge which was exposed and perfectly accessible, quite characteristic. These mycelia were first carefully removed, and the underlying surface of wood repeatedly soaked on successive days with a strong solution of copper sulphate. The "hymenium," with its characteristic wrinkling and rusty spores, not having been developed, I concluded that the chances of the fungus spreading (should it do so) to other timbers would only take place by burrowing of the mycelia. This process of repeated soakings with the saline solution, with thorough drying in the intervals—the ventilation being very perfect—was continued for some weeks before the "curative" part of the experiment was concluded by coating the piece of wood upon every surface with a thick layer of paint and varnish.

Before this was done, chips and borings were examined which showed the mycelia in the surface layers apparently completely shrivelled and devitalised,—a consummation the *permanence* of which it will be the purpose of an investigation some months hence to corroborate, or otherwise.

From recent tests and present experiences I am, however, of opinion that those portions of the fungus which come within the range of the treatment just mentioned are not likely to crop up again, and the affected part, being perfectly local, is but little likely to give further opportunities of varying the experiment. Regarding any fears I might have respecting the possibilities of the fungus, which in this instance is

decidedly *Merulius lacrymans*, spreading to what are at present perfectly fresh timbers, I do not think that it has been established that such fresh timbers, if kept dry by good ventilation, are (even without a coating of paint) liable to attacks of this pest, at least by germination of fungus spores; for a hypha to perforate an adjoining piece of wood is another matter. Were spore transference at all potent in sowing such fungi on timbers which had been well seasoned, dry, and under the conditions of even moderate ventilation, one can scarcely see how such ravages should not be very much more frequent and severe than they are.

Of course, as a matter of sound practice in dealing with such occurrences in costly buildings, it is, perhaps, best to err on the safe side by the removal of much contiguous timber which may have been suffered to have come within the range of contamination, rather than resort to the more doubtful procedure of attempting to "cure" or arrest the progress of the fungus where it may have been supposed to have just got a hold, as in my experimental case. On the other hand, it is scarcely to be thought wonderful, or very much beyond the range of very ordinary possibilities, that the vitality of so delicate an organism as the spore or hypha of a fungus should readily succumb to quite a large number of destructive agencies, so chosen that all the valued qualities and characteristics of the infested wood, even its ornamental ones, may remain practically unaltered. The only difficulty—a very real one in most instances where buildings are concerned, as compared with isolated poles, etc.—is of the nature of the one experienced in endeavouring to catch a bird by "putting salt on its tail." At the same time, it is well to know that there are several very effective means of thoroughly destroying dry-rot fungi other than by prompt commitment of the whole affair to the flames. I only chose the copper salt because it came readiest to hand. As we all know, creosote has perhaps the greatest reputation in this direction. If one who can lay no special claim to a knowledge of this subject might venture to express an opinion as to the means of prevention, I think it will

be found that the two great "predisposing causes," as physicians would say, are in this case the use of imperfectly seasoned timber, and the enclosing of timbers where good ventilation is impossible.

## THE PHANEROGAMIC FLORA OF THE CLOVA MOUNTAINS IN SPECIAL RELATION TO FLOWER BIOLOGY. By J. C. WILLIS, M.A., and J. H. BURKILL, M.A.

(Read 12th December 1901.)

The present paper enumerates the Phanerogamic Flora of Clova, classifies the species in it by their flower biology, and gives our own observations upon their distribution in altitude and time of flowering. Our purpose is to trace any connection which may exist between the flower biology and the two latter attributes.

To us the Clova region means strictly the southern face of the Grampians within convenient distance of Milton of Clova, *i.e.* Glen Clova above Dykehead, Glen Prosen above Inchmill, and the moors of the North Esk above Loch Lee. The whole area approximately comprises—

Above 3000 feet, one-third square mile.
2500–3000 feet, 20 square miles.
2000–2500 ,, 28 ,,
1500–2000 ,, 18 ,,
1000–1500 ,, 28 ,,
500–1000 ,, 9 ,,

It consists of three conditions—the valley bottoms or straths, the hillsides with their crags, and the peaty moors. The latter begin at 2500–2600 feet.

82 Phanerogams grow on the moors, 4 being confined to them.
263 ,, ,, hillsides, 35 ,, ,,
298 ,, ,, straths, 97 ,, ,,

The total number of self-maintaining Phanerogams is 363; there are also 16 others maintained by man through agriculture or arboriculture, and these are distinguished in the list which follows by wanting the consecutive numbering, and by inclusion at the same time in brackets.

Of the 363 self-maintaining Phanerogams, 81 are to be reckoned as alpines, and 282 as lowland plants. All the

latter can be found below 1000 feet; the former are found in greatest number between 2000 and 2500 feet.

We have made use of the many published papers on the Clova Flora. We have corrected our altitudes by the work of the Ordnance Survey, and have found frequent cause to discard, or modify from local knowledge, the published statements of botanists regarding heights attained by Clova plants. We have been favoured by the help of many friends, among whom are Prof. F. O. Bower, Messrs. Arthur Bennett, H. H. W. Pearson, A. G. Tansley, F. J. Hanbury (for names of Hieracia), and Rev. E. F. Linton (for names of Hieracia), the late Robert Smith, Dr. W. H. Lang, Rev. F. R. Tennant, and Miss C. E. Hemsley,—to them we tender our best thanks, as also to those who permitted us in successive years to botanise on their property.

We are primarily concerned with the flower-classes first limited by Hermann Muller, and, because opinions differ as to their definition, we may here add a word in explanation of the way in which we use them. Flowers habitually fertilised by the wind belong to class W; simple flowers, without honey, to class Po. Upright, or more or less upright, simple flowers belong, according to the depth at which the honey lies, to classes A (freely exposed), AB (half-hidden), B (completely hidden), $B^1$ (completely hidden and the flowers crowded), H (deeply hidden, the depth suited to a bee proboscis), and F (the same, but suited to a butterfly's proboscis). Pendent flowers are raised a class at least by the difficulty of obtaining their honey, thus *Acer pseudo-platanus* belongs to class AB, though its honey is exposed, and *Geranium phæum* belongs to class H, though the position of its honey would place it in B. Complex flowers without honey may belong to class H, and many nocturnal flowers go into class F, which, by structure, were they diurnal, would be distributed between classes B, H, and F, *e.g. Habenaria albida*, which if visited by day-insects would belong to class B.

In our opinion the final test in all doubtful cases is in the circle of insect visitors. We have studied these, and intend to detail our observations in the "Annals of Botany."

Other abbreviations used are—ch, completely hidden honey; dh, deeply hidden honey (more than 5 mm.); hh, half-hidden honey; exp, exposed honey.

## THE PHANEROGAMIC FLORA OF CLOVA.

| | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|
| Ranunculaceæ— | | | | |
| 1. Thalictrum alpinum, Linn. | ... | W | 18–3000 | mid. v.–vi. |
| 2. Anemone nemorosa, Linn. | none | Po | –2500 | v.–early vi. |
| 3. Ranunculus Flammula, Linn. | hh | AB | –2300 | mid. vi.–ix. |
| 4. —— auricomus, Linn. | hh | AB | –800 (and at 2000) | v. |
| 5. —— acris, Linn. | hh | AB | –3000 | end v.–ix. |
| 6. —— repens, Linn. | hh | AB | –800 (and at 2300) | end v.–vii. |
| 7. —— bulbosus, Linn. | hh | AB | –1100 | vi. |
| 8. —— Ficaria, Linn. | hh | AB | –900 | end iv.–v. |
| 9. Caltha palustris, Linn. | hh | AB | –3200 | v.–vi. |
| 10. Trollius europæus, Linn. | hh | AB | –2600 | end v.–vi. |
| Cruciferæ— | | | | |
| 11. Barbarea vulgaris, R. Br. | hh | AB | –800 | vi. |
| 12. Arabis hirsuta, R. Br. | hh | AB | 20–2400 | end vi.–vii. |
| 13. Cardamine pratensis, Linn. | ch | B | –2700 | v.–early vii. |
| 14. —— hirsuta, Linn. (with C. flexuosa, With.) | hh | AB | –2400 | v.–vi. |
| 15. Draba incana, Linn. | hh | AB | 20–2400 | mid. vi.–vii. |
| 16. Erophila vulgaris, DC. | hh | AB | –900 | mid. iv.–v. |
| 17. Cochlearia officinalis, Linn. (with C. danica, Linn.) | hh | AB | 20–3000 | vi.–mid. vii. |
| 18. Subularia aquatica, Linn. | hh | AB | 2100 | vii.–viii. |
| 19. Brassica Sinapis, Vis. | hh | AB | –900 | mid. vi.–viii. |
| 20. Capsella Bursa-pastoris, Mœnch. | hh | AB | –800 | end iv.–ix. |
| 21. Raphanus Raphanistrum, Linn. | ch | B | –900 | mid. vi.–ix. |
| Cistaceæ— | | | | |
| 22. Helianthemum vulgare, Gærtn. | none | Po | –1600 | mid. vi.–mid. ix. |
| Violaceæ— | | | | |
| 23. Viola palustris, Linn. | ch | H | –3000 | v.–mid. vi. |
| 24. —— canina, Linn. | ch | H | –2500 | v.–vi. |
| 25. —— sylvestris, Fries. | dh | H | –2500 | v.–vi. |
| 26. —— tricolor, Linn. | ch | H | –800 | mid. v.–mid. vii. |
| 27. —— arvensis, Murr. | ch | H | –800 | mid. v.–ix. |
| 28. —— lutea, Huds. | dh | H | –2000 | v.–ix. |
| Polygalaceæ— | | | | |
| 29. Polygala vulgaris, Linn. | ch | H | –2500 | end v.–vii. |
| 30. —— serpyllacea, Weihe | ch | H | –2400 | end v.–vii. (also ix.). |
| Caryophyllaceæ— | | | | |
| (*Silene Cucubalus*, Wibel. | dh | F | –800 | ? vi.) |
| 31. —— acaulis, Linn. | dh | F | 19–3300 | mid. vi.–mid. vii. |
| 32. Lychnis diurna, Sibth. | dh | F | –900 (and 22–2400) | mid. v.–vii. |
| 33. —— Flos-cuculi, Linn. | dh | H | –1500 | end vi.–vii. (seen ix.). |
| 34. —— alpina, Linn. | dh | H | 2900 | end vi.–vii. |
| 35. Cerastium glomeratum, Thuillier. | hh | AB | –900 | end v.–ix. |
| 36. —— triviale, Link. | hh | AB | –2900 | v.–early ix. |
| 37. —— alpinum, Linn. | hh | AB | 20–3000 | end v.–early ix. |

| | | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|---|
| | Caryophyllaceæ—*cont.* | | | | |
| 38. | Stellaria media, Cyr. | hh | AB | -1000 | mid. iv.–ix. |
| 39. | —— Holostea, Linn. | hh | AB | 800 (and 20–2100) | vi.-early vii. |
| 40. | —— graminea, Linn. | hh | AB | -1400 | mid. vi.–mid. ix. |
| 41. | —— uliginosa, Murr. | hh | AB | -1500 | vi.-vii. |
| 42. | Arenaria trinervia, Linn. | hh | AB | -600 | vi. |
| 43. | —— sedoides, Linn. | exp | A | 2950 | vi. |
| 44. | Sagina procumbens, Linn. | hh | AB | -2100 | end vi.–mid. ix. |
| 45. | —— Linnæi, Presl. (with S. nivalis, Fries.) | hh | AB | 23-2700 | vii.–viii. |
| 46. | —— subulata, Presl. | hh | AB | -2100 | mid. vi.–mid. ix. |
| 47. | Spergula arvensis, Linn. | hh | AB | -800 | mid. vi.–ix. |
| | Portulacaceæ— | | | | |
| 48. | Montia fontana, Linn. | hh | AB | -2600 | mid. v.–ix. |
| | Hypericaceæ— | | | | |
| 49. | Hypericum humifusum, Linn. | none | Po | -800 | vii.–early viii. |
| 50. | —— pulchrum, Linn. | none | Po | -2300 | mid. vi.–ix. |
| | Linaceæ— | | | | |
| 51. | Linum catharticum, Linn. | hh | AB | -2200 | mid. vi.–mid. ix. |
| | Geraniaceæ— | | | | |
| 52. | Geranium phæum, Linn. | ch | H | 800 | mid. vi.–mid. vii. |
| 53. | —— sylvaticum | ch | B | -2500 | mid. vi.-early viii. |
| 54. | —— molle, Linn. | ch | B | -800 | vii.–ix. |
| 55. | —— dissectum, Linn. | ch | B | -800 | viii.–ix. |
| 56. | —— Robertianum, Linn. | ch | B | -2100 | end v.–mid. viii. |
| 57. | Oxalis Acetosella, Linn. | hh | AB | -2600 | v.–mid. vi. |
| | (*Acer pseudo-platanus*, Linn. | exp | AB | -900 | mid. v.–mid. vi.) |
| | Leguminosæ— | | | | |
| 58. | Genista anglica, Linn. | none | H | -2500 | v.–early vii. |
| 59. | Ulex europæus, Linn. | none | H | -1000 | end iv.–mid. vi. |
| 60. | Cytisus scoparius, Link. | none | H | -2300 | v.–vi. |
| 61. | Trifolium pratense, Linn. | dh | H | -1600 | mid. vi.–ix. |
| | (*Trifolium hybridum*, Linn. | ch | H | -900 | end vi.–ix.) |
| 62. | —— repens, Linn. | ch | H | -2300 | mid. vi.–ix. |
| 63. | Anthyllis vulneraria, Linn. | dh | H | -2000 | vii.–viii. |
| 64. | Lotus corniculatus, Linn. | dh | H | -2500 | end vi.–mid. viii. |
| 65. | Astragalus alpinus, Linn. | dh | H | 21-2500 | vii.–early viii. |
| 66. | Oxytropis campestris, DC. | dh | H | 20-2400 | mid. vi.–mid. vii. |
| | (*Vicia hirsuta*, Koch. | ch | H | -800 | viii.) |
| 67. | Vicia Cracca, Linn. | dh | H | -900 | mid. vi.–early viii. |
| 68. | —— sylvatica, Linn. | dh | H | 20-2300 | end vi.–early viii. |
| 69. | —— sepium, Linn. | dh | H | -1900 | vi.–vii. |
| 70. | Lathyrus pratensis, Linn. | dh | H | -900 | mid. vi.–mid. ix. |
| 71. | —— Macrorrhizus, Wimm. | dh | H | -2300 | mid. v.–vi. (seen ix.). |
| | Rosaceæ— | | | | |
| | (*Prunus Avium*, Linn. | ch | H | -900 | mid. v.–early vi.) |
| 72. | Prunus Padus, Linn. | hh | B | -2200 | mid. v.–early vi. |
| 73. | Spiræa Ulmaria, Linn. | none | Po | -1100 (and at 1900) | end vi.–early viii. |
| 74. | Rubus Idæus, Linn. | ch | H | -2300 | early vi.–early vii. |
| 75. | —— suberectus, Anders. | ch | B | -800 | mid. vi.–mid. vii. |
| 76. | —— saxatilis, Linn. | ch | H | 20-2300 (and at 1500) | mid. vi.–early vii. |
| 77. | —— chamæmorus, Linn. | ch | B | 17-3000 | end v.-early vii. |
| 78. | Dryas octopetala, Linn. | ch | B | 20-2500 | mid. vi.–mid. vii. |
| 79. | Geum rivale, Linn. | ch | H | -2500 | end v.–mid. vii. |
| 80. | Fragaria vesca, Linn. | hh | AB | -2200 | vi.–mid. vii. |
| 81. | Potentilla Fragariastrum, Ehrh. | hh | AB | -1700 | mid. v.–vii. |
| 82. | —— alpestris, Hall. f. | hh | AB | 15-2400 | end v.–vii. |
| 83. | —— Tormentilla, Scop. | hh | AB | -2700 | mid. v.–ix. |

| | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|
| Rosaceæ—*cont.* | | | | |
| 84. Potentilla Anserina, Linn. | hh | AB | -800 | vii.-viii. |
| 85. —— Comarum, Nestl. | hh | AB | -900 | mid. vi.-vii. |
| 86. —— Sibbaldi, Hall. f. | exp | A | 24-3200 | vi.-mid. vii. |
| 87. Alchemilla arvensis, Lamk. | none | Po | -800 | v.-ix. |
| 88. —— vulgaris, Linn. | exp | A | -2500 | v.-ix. |
| 89. —— alpina, Linn. | exp | A | 6-3300 | mid. v.-ix. |
| 90. —— conjuncta, Bab. | exp | A | about 1800 | mid. vi.-vii. |
| 91. Rosa involuta, Sm. | none | Po | -1300 | mid. vi.-vii. |
| 92. —— villosa, Linn. | none | Po | -900 (and 20-2400) | end vi.-early viii. |
| 93. Pyrus Aucuparia, Gærtn. | exp | A | -2300 | vi. |
| (*Cratægus Oxyacantha*, Linn. | hh | A | -800 | vi.) |
| Saxifragaceæ— | | | | |
| 94. Saxifraga oppositifolia, Linn. | ch | B | 10-2500 | mid. iv.-mid. vi. (seen ix.) |
| 95. —— nivalis, Linn. | hh | AB | 19-2500 | end vi.-mid. vii. |
| 96. —— stellaris, Linn. | exp | A | 7-3000 | end v.-early vii. |
| 97. —— umbrosa, Linn. | exp | A | -900 | vi. |
| 98. —— aizoides, Linn. | exp | A | 7-2500 | mid. vi.-ix. |
| 99. —— hypnoides, Linn. | hh | AB | 14-2700 | end v.-early vii. |
| 100. Chrysosplenium oppositifolium, Linn. | exp | A | -2500 | v.-mid. vii. |
| 101. —— alternifolium, Linn. | exp | A | 22-2300 (and ? below) | mid. v.-early vi. |
| 102. Parnassia palustris, Linn. | hh | AB | -2500 | end vi.-ix. |
| 103. Ribes Grossularia, Linn. | hh | AB | -900 | v. |
| 104. —— rubrum, Linn. | hh | AB | -900 | v. |
| 105. Ribes nigrum, Linn. | ch | B | -900 | v. |
| Crassulaceæ— | | | | |
| 106. Sedum Rhodiola, DC. | hh | AB | 20-2700 | end v.-mid. vii. |
| (*Sedum album*, Linn. | hh | AB | -900 | vii.-early viii.) |
| Droseraceæ— | | | | |
| 107. Drosera rotundifolia, Linn. | hh | AB | -1500 | end vi.-mid. viii. |
| Haloragidaceæ— | | | | |
| 108. Myriophyllum alternifolium, DC. | ... | W | -900 | viii. |
| 109. Callitriche verna, Linn. (with C. hamulata, Kutz.) | ... | W | -900 | viii.-ix. |
| Onagraceæ— | | | | |
| 110. Epilobium angustifolium, Linn. | ch | B | -2500 | end vi.-viii. |
| 111. —— montanum, Linn. | ch | B | -2300 | end vi.-mid. viii. |
| 112. —— tetragonum, Linn. | ch | B | -1400 | vii.-viii. |
| 113. —— palustre, Linn. | ch | B | -1500 | mid. vii.-early ix. |
| 114. —— alsinefolium, Vill. | ch | B | 9-2600 | mid. vi.-vii. |
| 115. —— alpinum, Linn. | ch | B | 15-2800 | mid. vi.-vii. |
| Umbelliferæ— | | | | |
| 116. Sanicula europæa, Linn. | exp | A | about 1000 | end vi.-vii. |
| (*Ægopodium Podagraria*, Linn. | exp | A | -800 | end vi.-vii.) |
| 117. Pimpinella Saxifraga, Linn. | exp | A | -900 | vii.-ix. |
| 118. Conopodium denudatum, Koch. | exp | A | -1400 | vi.-early vii. |
| 119. Myrrhis odorata, Scop. | exp | A | -600 | mid. v.-vi. |
| 120. Anthriscus sylvestris, Hoffm. | exp | A | -900 | end v.-mid. viii. |
| 121. Meum athamanticum, Jacq. | exp | A | 7-900 | end v.-vii. |
| 122. Angelica sylvestris, Linn. | exp | A | -900 (and 20-2400) | end viii.-ix. |
| 123. Heracleum Sphondylium, Linn. | exp | A | -2300 | end vi.-mid. ix. |

| | | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|---|
| | Araliaceæ— | | | | |
| | (*Hedera Helix*, Linn. | exp | A | –800 | ? never). |
| | Cornaceæ— | | | | |
| 124. | Cornus suecica, Linn. | exp | A | 18–2600 | end v.–mid. vii. |
| | Caprifoliaceæ— | | | | |
| | (*Sambucus nigra*, Linn. | none | Po | –800 | viii.) |
| 125. | Linnæa borealis, Gronov. | ch | B | 18–2000 | end vi.–mid. vii. |
| 126. | Lonicera Periclymenum, Linn. | dh | F | 800 (and 1700) | mid. vi.–mid. vii. |
| | Rubiaceæ— | | | | |
| 127. | Galium boreale, Linn. | exp | A | 7–2400 | mid. vi.–vii. |
| 128. | —— verum, Linn. | exp | A | –900 | mid. vi.–ix. |
| 129. | —— saxatile, Linn. (with G. Sylvestre, Poll) | exp | A | –3200 | end v.–ix. |
| 130. | —— palustre, Linn. | exp | A | –900 | vii.–mid. viii. |
| 131. | —— Aparine, Linn. | exp | A | –900 | vi.–mid. viii. |
| 132. | Asperula odorata, Linn. | ch | B | –1000 | mid. vi.–mid. vii. |
| | Valerianaceæ— | | | | |
| 133. | Valeriana officinalis, Linn. | ch | B | –1900 | mid. v.–early viii. |
| | Dipsacaceæ— | | | | |
| 134. | Scabiosa Succisa, Linn. | ch | $B^1$ | –2400 | mid. vii.–ix. |
| | Compositæ— | | | | |
| 135. | Solidago Virg-aurea, Linn. | ch | $B^1$ | –3000 | mid. vi.–ix. |
| 136. | Bellis perennis, Linn. | ch | $B^1$ | –2500 | iv.–ix. |
| 137. | Erigeron alpinum, Linn. | ch | $B^1$ | 20–2100 | end vi.–vii. |
| 138. | Antennaria dioica, R. Br. | ch | $B^1$ | –2700 | mid. v.–early vii. |
| | (*Antennaria margaritacea*, R. Br. | ch | $B^1$ | –800 | mid. vii.–mid. ix.) |
| 139. | Gnaphalium sylvaticum, Linn. | ch | $B^1$ | –1200 | end vii.–mid. ix. |
| 140. | —— supinum, Linn. | ch | $B^1$ | 23–3000 | mid. vi.–early viii. |
| 141. | Achillea Millefolium, Linn. | ch | $B^1$ | –1800 | end v.–ix. |
| 142. | —— Ptarmica, Linn. | ch | $B^1$ | –1500 | vii.–ix. |
| 143. | Chrysanthemum Leucanthemum, Linn. | ch | $B^1$ | –1500 | end vi.–mid. ix. |
| 144. | Matricaria inodora, Linn. | ch | $B^1$ | –800 | end vi.–ix. |
| 145. | Artemisia vulgaris, Linn. | ... | W | –800 | viii. |
| 146. | Tussilago Farfara, Linn. | ch | $B^1$ | –2100 | iv., mid. v. |
| 147. | Senecio vulgaris, Linn. | ch | $B^1$ | –800 | v.–ix. |
| 148. | —— sylvaticus, Linn. | ch | $B^1$ | –800 | vii.–ix. |
| 149. | —— Jacobæa, Linn. | ch | $B^1$ | –1300 | end vi.–ix. |
| 150. | —— aquaticus, Huds. | ch | $B^1$ | –800 | end vi.–mid. ix. |
| 151. | Cnicus lanceolatus, Hoffm. | ch | $B^1$ | –2300 | end vii.–ix. |
| 152. | —— palustris, Hoffm. | ch | $B^1$ | –2500 | mid. vi.–ix. |
| 153. | —— heterophyllus, Willd. | ch | $B^1$ | –2500 | mid. vi.–ix. |
| 154. | —— arvensis, Hoffm. | ch | $B^1$ | –900 | viii.–ix. |
| 155. | Saussurea alpina, DC. | ch | $B^1$ | 20–2400 | mid. vi., mid. viii. |
| 156. | Centaurea nigra, Linn. | ch | $B^1$ | –900 | viii.–ix. |
| | (*Centaurea Cyanus*, Linn. | ch | $B^1$ | –600 | mid. vii.–viii.) |
| 157. | Lapsana communis, Linn. | ch | $B^1$ | –800 | vii.–viii. |
| 158. | Crepis paludosa, Mœnch. | ch | $B^1$ | –2300 | end vi.–mid. ix. |
| 159. | Hieracium Pilosella, Linn. | ch | $B^1$ | –2500 | mid. vi.–ix. |
| 160. | —— alpinum, Linn. (H. alpinum, segregate; H. holo-sericeum, Backh.; H. eximium, Backh.; H calenduliflorum, Backh.; H. gracilentum, Backh.) | ch | $B^1$ | 20–2700 | mid. vi., early viii. |
| 161. | —— nigrescens, Willd. (H. lingulatum, Backh.; H. senescens, Backh.; H. Marshall, Linton; H. chrysanthum, Backh.) | ch | $B^1$ | 8–2700 | mid. vi., early viii. |

| | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|
| **Compositæ**—*cont.* | | | | |
| 162. Hieracium anglicum, Fries. (H. callistiphyllum, F. J. Hanb.; H. anglicum, segregate; H. cerinthiforme, Backh.; H. iricum, Fries.; H. clovense, Linton) | ch | $B^1$ | 8–2500 | mid. vi., early viii. |
| 163. —— murorum, Linn. (H. Leyi. F. J. Hanb.; H. Schmidtii, Tausch.; H. lasiophyllium, Koch.; H. argentium, Fries.; H. aggregatum, Backh.; H. Pictorum, Linton; H. rivale, F. J. Hanb.; H. murorum, segregate) | ch | $B^1$ | 8–2700 | mid. vi.–viii. |
| 164. —— sylvaticum, Sm. (H. euprepes, F. J. Hanb.; H. vulgatum, Fries.; H. angustatum, Lindeb.; H. diaphanoides, Lindeb.) | ch | $B^1$ | –2300 | mid. vi.–ix. |
| 165. —— crocatum, Fries. (H. gothicum, Backh.; H. rigidum, Hartm.: H. dovrense, Fries.; H. auratum, Fries.) | ch | $B^1$ | –2300 | mid. vi.–viii. |
| 166. —— umbellatum, Linn. | ch | $B^1$ | ? to about 800 | viii.–ix. |
| 167. Hypochœris radicata, Linn. | ch | $B^1$ | –1600 | mid. vi.–ix. |
| 168. Leontodon autumnalis, Linn. | ch | $B^1$ | –2900 | end vi.–ix. |
| 169. Taraxacum officinale, Web. | ch | $B^1$ | –2700 | v.–mid. ix. |
| 170. Lactuca alpina, Benth. | ch | $B^1$ | 2000 | mid. vii.–viii. |
| **Campanulaceæ**— | | | | |
| 171. Lobelia Dortmanna, Linn. | dh | H | at 2100 | viii. |
| 172. Campanula rotundifolia, Linn. | ch | H | –2800 | mid. vi.–ix. |
| **Vacciniaceæ**— | | | | |
| 173. Vaccinium Vitis-Idæa, Linn. | ch | H | –3200 | end v.–ix. |
| 174. —— uliginosum, Linn. | ch | H | 17–3000 | vi.–vii. |
| 175. —— Myrtillus, Linn. | dh | H | –3200 | mid. v.–vii. |
| 176. —— Oxycoccos, Linn. | hh | AB | –3000 | mid. vi.–early viii. |
| **Ericaceæ**— | | | | |
| 177. Arctostaphylos alpina, Spreng. | ch | H | 2200 | end v.–mid. vi. |
| 178. —— Uva-ursi, Spreng. | ch | H | 7–2800 | mid. v.–vi. |
| 179. Calluna vulgaris, Salisb. | ch | B | –3000 | end vi.–ix. |
| 180. Erica Tetralix, Linn. | dh | H | –2000 | mid. vi.–ix. |
| 181. —— cinerea, Linn. | dh | H | –2500 | mid. vi.–ix. |
| 182. Loiseleuria procumbens, Desv. | hh | AB | 23–3300 | end v.–early vii. |
| 183. Pyrola rotundifolia, Linn. | none | Po | –2100 | end vi.–vii. |
| 184. —— media, Sw. | none | Po | –1800 | vii. |
| 185. —— minor, Sw. | none | Po | 2100 | end vi.–vii. |
| 186. —— secunda, Linn. | ch | H | 20–2500 | end vi.–vii. |
| **Plumbaginaceæ**— | | | | |
| 187. Armeria maritima, Willd. | ch | $B^1$ | 2900 | mid. vi.–mid. vii. |
| **Primulaceæ**— | | | | |
| 188. Primula vulgaris, Huds. | dh | H | –1400 | v.–early vi. |
| 189. —— veris, Linn. | dh | H | –800 | mid. v.–early vi. |
| 190. Lysimachia punctata, Linn. | none | Po | –900 | vii.–mid. viii. |
| 191. —— nemorum, Linn. | none | Po | –2200 | end v.–mid. vii. |
| 192. Trientalis europæa, Linn. | none | Po | –3000 | end v.–early vii. |
| **Oleaceæ**— | | | | |
| 193. Fraxinus excelsior, Linn. | ... | W | –900 | end iv.–mid. v. |

| | | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|---|
| | GENTIANACEÆ— | | | | |
| 194. | Gentiana campestris, Linn. | dh | F | -2400 | vii.-ix. |
| 195. | Menyanthes trifoliata, Linn. | ch | B | -800 | mid. vi.-vii. |
| | BORAGINACEÆ— | | | | |
| 196. | Symphytum officinale, Linn. | dh | H | -800 | mid. vi.-mid. vii. |
| 197. | Anchusa sempervirens, Linn. | ch | B | 500 | vi. |
| 198. | Myosotis cæspitosa, Schultz. | ch | B | -900 | vii.-ix. |
| 199. | —— repens, D. Don. | ch | B | -1500 | mid. vi.-vii. |
| 200. | —— arvensis, Hoffm. | ch | B | -800 | mid. vi.-ix. |
| 201. | —— versicolor, Reichb. | ch | B | -800 | mid. vi.-ix. |
| | SCROPHULARIACEÆ— | | | | |
| 202. | Scrophularia nodosa, Linn. | ch | H | -900 | end vi.-vii. |
| 203. | Mimulus Langsdorffii, Donn. | dh | H | -900 | mid. vi.-vii. |
| 204. | Digitalis purpurea. Linn. | dh | H | -2100 | mid. vi.-ix. |
| 205. | Veronica agrestis, Linn. | ch | B | -800 | end v.-ix. |
| 206. | —— Buxbaumii, Ten. | ch | B | -800 | end iv.-ix. |
| 207. | —— arvensis, Linn. | ch | B | -900 | v.-ix. |
| 208. | —— serpyllifolia, Linn. | ch | B | -2400 | v.-ix. |
| 209. | —— alpina. Linn. | ch | B | 20-2600 | end vi.-mid. vii. |
| 210. | —— saxatilis, Linn. | ch | B | 24-2500 | mid. vi -mid. vii. |
| 211. | —— officinalis, Linn. | ch | B | -2200 | mid. vi -mid. ix |
| 212. | —— Chamædrys, Linn. | ch | B | -2200 | end v., early viii. |
| 213. | —— scutellata, Linn. | ch | B | -1400 | mid. vi.-mid viii. |
| 214. | —— Beccabunga, Linn. | ch | B | -1700 | mid. vi.-ix. |
| 215. | Euphrasia officinalis, Linn. | ch | H | -3000 | vii.-ix. |
| 216. | Pedicularis palustris, Linn. | dh | H | -1300 | end vi.-mid. ix. |
| 217. | —— sylvatica, Linn. | dh | H | -2000 | end v.-mid. ix. |
| 218. | Rhinanthus Crista-galli, Linn. | dh | H | -2500 | mid. vi.-vii. |
| 219. | Melampyrum pratense, Linn. | ch | H | -2600 | mid. vi.-vii. |
| | LENTIBULARIACEÆ— | | | | |
| 220. | Utricularia minor, Linn. | ch | H | -800 | vii. |
| 221. | Pinguicula vulgaris, Linn. | ch | H | -2800 | mid. v.-vii. |
| | LABIATÆ— | | | | |
| | (*Mentha rotundifolia*, Huds. | ch | B | 900 | end viii.-ix.) |
| 222. | Mentha arvensis, Linn. | ch | B | -800 | end vii.-ix. |
| 223. | Thymus Serpyllum, Fries. | ch | B | -2300 | mid. vi.-ix. |
| 224. | Nepeta Glechoma, Benth. | dh | H | -800 | v. |
| 225. | Prunella vulgaris, Linn. | dh | H | -2300 | mid. vi -mid. ix. |
| 226. | Stachys palustris, Linn. | dh | H | -900 | vii.-viii. |
| 227. | Galeopsis Tetrahit, Linn. | dh | H | -800 | end vi.-ix. |
| 228. | Lamium purpureum, Linn. | dh | H | -800 | v.-ix. |
| 229. | —— maculatum, Linn. | dh | H | 800 | v.-mid. vi. |
| 230. | Ajuga reptans, Linn. | dh | H | -2200 | end v.-vi. |
| | PLANTAGINACEÆ— | | | | |
| 231. | Plantago major, Linn. | ... | W | -900 | mid. vi.-ix. |
| 232. | —— lanceolata, Linn. | ... | W | -1300 | mid. v.-mid. ix. |
| 233. | —— maritima, Linn. | ... | W | -1100 | vii.-early viii. |
| | ILLECEBRACEÆ— | | | | |
| 234. | Scleranthus annuus, Linn. | hh | AB | -800 | vii.-ix. |
| | CHENOPODIACEÆ— | | | | |
| 235. | Chenopodium Bonus-Henricus, Linn. | none | Po | -800 | mid. vi.-mid. vii. |
| | POLYGONACEÆ— | | | | |
| 236. | Polygonum aviculare, Linn. | none | Po | -800 | end vi.-ix. |
| 237. | —— Persicaria, Linn. | ch | B | -1300 | viii.-ix. |
| 238. | —— viviparum, Linn. | ch | B | 7-3000 | mid. vi.-mid. ix. |
| 239. | Oxyria digyna, Hill | ... | W | 6-3000 | mid. vi.-vii. |
| 240. | Rumex conglomeratus, Murr. | ... | W | -700 | mid. vi.-ix. |
| 241. | —— obtusifolius, Linn. | ... | W | -800 | viii.-ix. |
| 242. | —— crispus, Linn. | ... | W | -800 | mid. vi.-ix. |
| 243. | —— aquaticus, Linn. | ... | W | 6-1000 | vii.-viii. |
| 244. | —— Acetosa, Linn. | ... | W | -2600 | vi.-mid. viii. |
| 245. | —— Acetosella, Linn. | ... | W | -2700 | end v.-mid. ix. |

| | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|
| Euphorbiaceæ— | | | | |
| 246. Mercurialis perennis, Linn. | ... | W | -2000 | v.-vi. |
| Urticaceæ— | | | | |
| 247. Ulmus montana, Sm. | ... | W | -1400 | iv.-early v. |
| 248. ? Urtica dioica, Linn. | ... | W | -2000 | mid. vi.-ix. |
| 249. Urtica urens, Linn. | ... | W | -700 | mid. vi.-ix. |
| Cupuliferæ— | | | | |
| 250. Betula alba, Linn. | ... | W | -2100 | mid. v.-mid. vi. |
| 251. —— nana, Linn. | ... | W | 24-2700 | vi.-mid. vii. |
| 252. Alnus glutinosa, Gærtn. | ... | W | -1300 | iv.-early v. |
| 253. Corylus Avellana, Linn. | ... | W | -1000 and) 20-2100) | iv. |
| (*Quercus Robur*, Linn. | ... | W | -900 | v.) |
| (*Fagus sylvatica*, Linn. | ... | W | -1000 | mid.-end v.) |
| Salicaceæ— | | | | |
| 254. Salix aurita, Linn. | hh | AB | -1600 | end iv.-v. |
| 255. —— Caprea, Linn. (with S. cinerea, Linn.) | hh | AB | -1700 | end iv.-vi. |
| 256. —— repens, Linn. | hh | AB | -2400 | v.-mid. vi. |
| 257. —— phylicifolia, Linn. (with S. nigricans, Sm.) | hh | AB | -2500 | v.-vi. |
| 258. —— Arbuscula, Linn. | hh | AB | 13-2200 | mid. v.-vi. |
| (*Salix viminalis*, Linn. | hh | AB | -800 | end iv.-early v.) |
| 259. —— lanata, Linn. | hh | AB | 2400 | end v., early vi. |
| 260. —— Lapponum, Linn. | hh | AB | 13-2500 | mid. v.-mid. vi. |
| 261. —— Myrsinites, Linn. | hh | AB | 20-2500 | vi. |
| 262. —— herbacea, Linn. | hh | AB | 23-3300 (and at 2100) | mid. v.-vi. |
| 263. —— reticulata, Linn. | hh | AB | 2000 | end. vi., early vii. |
| 264. Populus tremula, Linn. | ... | W | -2200 | iv. |
| Empetraceæ— | | | | |
| 265. Empetrum nigrum, Linn. | ... | W | -3100 | iv.-vi. |
| Orchidaceæ— | | | | |
| 266. Malaxis paludosa, Sw. | hh | AB | -1500 | vii. |
| 267. Listera cordata, R. Br. | exp | AB | -2100 | mid. vi.-mid. vii. |
| 268. Orchis mascula, Linn. | ch | H | -2000 | mid. vi.-vii. |
| 269. —— maculata, Linn. | ch | H | -2600 | vi.-mid. vii. |
| 270. Habenaria conopsea, Benth. | dh | F | -1100 | end vi.-early viii. |
| 271. —— albida, R. Br. | ch | F | -2200 | mid. vi.-mid. vii. |
| 272. —— viridis, R. Br. | ch | B | 20-2600 | end vi.-vii. |
| 273. —— chlorantha, Bab. | dh | F | -900 | vii. |
| Liliaceæ— | | | | |
| 274. Narthecium Ossifragum, Huds. | none | Po | -2600 | mid. vi.-ix. |
| 275. Tofieldia palustris, Huds. | hh | AB | 8-2500 | end vi.-vii. |
| Juncaceæ— | | | | |
| 276. Juncus bufonius, Linn. | ... | W | -800 | mid. vii.-viii. |
| 277. —— trifidus, Linn. | ... | W | 24-3300 | mid. vi., early viii. |
| 278. —— squarrosus, Linn. | ... | W | -2600 | mid. vi.-ix. |
| 279. —— effusus, Linn. (with J. conglomeratus, Linn.) | ... | W | -1900 | mid. vi.-viii. |
| 280. —— articulatus, Linn. (with J. supinus and J. lamprocarpus, Ehrh., Mœnch.) | ... | W | -2400 | mid. vi.-ix. |
| 281. —— castaneus, Linn. | ... | W | 24-2600 | vi.-early vii. |
| 282. —— triglumis, Linn. | ... | W | 18-2600 (and at 1500) | mid. vi.-mid. vii. |
| 283. Luzula vernalis, DC. | ... | W | -2300 | v.-vi. |
| 284. —— maxima, DC. | ... | W | -2300 | v.-mid. vi. |
| 285. —— spicata, DC. | ... | W | 20-3300 | mid. vi.-vii. |
| 286. —— campestris, Willd. (with L. erecta, Desv.) | ... | W | -2600 | v.-mid. vi. |

| | | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|---|
| | Typhaceæ— | | | | |
| 287. | Sparganium natans, Linn. | ... | W | 6–1000 | end vi.–mid. viii. |
| | Naiadaceæ— | | | | |
| 288. | Triglochin palustre, Linn. | ... | W | –2600 | mid. vi.–mid. viii. |
| 289. | Potamogeton rufescens, Schrad. | ... | W | –900 | mid. vi.–mid. ix. |
| | Cyperaceæ— | | | | |
| 290. | Scirpus pauciflorus, Lightf. | ... | W | –1200 | vii.–viii. |
| 291. | —— cæspitosus, Linn. | ... | W | –3100 | vi.–early viii. |
| 292. | —— setaceus, Linn. | ... | W | –1400 | end vi.–vii. |
| 293. | Eriophorum vaginatum, Linn. | ... | W | –2800 | mid. iv.–v. |
| 294. | —— polystachion, Linn. (E. angustifolium, Roth.) | ... | W | –3100 | mid. v.–early vii. |
| 295. | Carex dioica, Linn. | ... | W | –2500 | mid. v.–early vii. |
| 296. | —— pulicaris, Linn. | ... | W | –2100 | mid. v.–vi. |
| 297. | —— rupestris, All. | ... | W | 20–2500 | vii. |
| 298. | —— pauciflora, Lightf. | ... | W | 2800 | mid. vi.–mid. vii. |
| 299. | —— echinata, Murr. | ... | W | –2500 | mid. vi.–vii. |
| 300. | —— canescens, Linn. | ... | W | –3300 | mid. vi.–vii. |
| 301. | —— leporina, Linn. | ... | W | –1100 | mid. vi.–mid. vii. |
| 302. | —— alpina, Swartz | ... | W | 24–2500 | end vi.–mid. vii. |
| 303. | —— atrata, Linn. | ... | W | 20–2500 | end vi.–mid. vii. |
| 304. | —— rigida, Good. | ... | W | 20–3300 | end v.–mid. vii. |
| 305. | —— aquatilis, Vahl. | ... | W | –3100 | end vi., early viii. |
| 306. | —— Goodenovii, Gay | ... | W | –2500 | end v.–early viii. |
| 307. | —— glauca, Murr. | ... | W | –1700 | end v.–early vii. |
| 308. | —— rariflora, Sm. | ... | W | 23–3000 | mid. vi–early vii. |
| 309. | —— pilulifera, Linn. | ... | W | –2400 | end v.–vi. |
| 310. | —— præcox, Jacq. | ... | W | –2000 | v.–early vi. |
| 311. | —— pallescens, Linn. | ... | W | –2000 | end vi.–vii. |
| 312. | —— panicea, Linn. | ... | W | –2200 | mid. vi.–vii. |
| 313. | —— vaginata, Tausch. | ... | W | 22–3100 | mid. vi.–vii. |
| 314. | —— capillaris, Linn. | ... | W | 19–2100 | mid. vi.–mid. vii. |
| 315. | —— binervis, Sm. | ... | W | –3000 | vi.–mid. vii. |
| 316. | —— distans, Linn. (with C. fulva, Good.) | ... | W | –1600 | end vi.–vii. |
| 317. | —— flava, Linn. (with C. Œderi, Ehrh.) | ... | W | –2500 | mid. vi.–vii. |
| 318. | —— ampullacea, Good. (C. rostrata, Stokes) | ... | W | –2600 | mid. vi.–vii. |
| 319. | —— vesicaria, Linn. (with C. saxatilis, Linn.) | ... | W | –2300 | end vi.–vii. |
| | Gramineæ— | | | | |
| 320. | Phalaris arundinacea, Linn. | ... | W | –600 | vii.–mid. viii. |
| 321. | Anthoxanthum odoratum, Linn. | ... | W | –2800 | mid. v.–vi. |
| 322. | Alopecurus geniculatus, Linn. | ... | W | –900 | mid. vi.–viii. |
| 323. | —— pratensis, Linn. | ... | W | –900 | vi.–early vii. |
| 324. | —— alpinus, Sm. | ... | W | 23–3000 | mid. vi.–vii. |
| 325. | Phleum alpinum, Linn. | ... | W | 21–2900 (and at 1500) | end vi.–vii. |
| 326. | —— pratense, Linn. | ... | W | –800 | end vi.–ix. |
| 327. | Agrostis canina, Linn. | ... | W | –2700 | mid. vi.–viii. |
| 328. | —— alba, Linn. | ... | W | –1900 | mid. vi.–ix. |
| 329. | —— vulgaris, With. | ... | W | –3000 | mid. vi.–ix. |
| 330. | Calamagrostis Epigeios, Roth. | ... | W | 20–2100 | vii. |
| 331. | Aira caryophyllea, Linn. | ... | W | –900 | mid. vi.–mid. vii. |
| 332. | —— præcox, Linn. | ... | W | –900 | end v.–vi. |
| 333. | Deschampsia cespitosa, Beauv. | ... | W | –2500 | mid. vi.–early viii. (also ix.) |
| 334. | —— flexuosa, Trin. | ... | W | –3300 | mid. vi.–viii. |
| 335. | Holcus mollis, Linn. | ... | W | –800 | end vi.–early viii |
| 336. | —— lanatus, Linn. | ... | W | –1100 | mid vi.–early ix (1 plant later.. |

| | Honey. | Class. | Altitude. | Month of Flowering. |
|---|---|---|---|---|
| Gramineæ—*cont.* | | | | |
| 337. Avena pratensis, Linn. | ... | W | –2100 | mid. vi.–vii. |
| 338. —— sativa, Linn. (with A. strigosa, Schreb.) | ... | W | –800 | vii. |
| 339. Arrhenatherum avenaceum, Beauv. | ... | W | –800 | vii.–early viii. |
| 340. Triodia decumbens, Beauv. | ... | W | –1100 | end vi.–vii. |
| 341. Cynosurus cristatus, Linn. | ... | W | –900 | mid. vi.–mid. viii. |
| 342. Kœleria cristata, Pers. | ... | W | –1000 | mid. vi.–early viii. |
| 343. Molinia cœrulea, Mœnch. | ... | W | –2600 | mid. vii.–mid. viii. |
| 344. Melica nutans, Linn. | ... | W | 19–2100 | mid. vi.–mid. vii. |
| 345. Dactylis glomerata, Linn. | ... | W | –2100 | mid. vi., early viii. |
| 346. Briza media, Linn. | ... | W | 900 | mid. vi.–vii. |
| 347. Poa annua, Linn. | ... | W | –2100 | iv.–ix. |
| 348. —— alpina, Linn. (with P. laxa, auct, angl.) | ... | W | 20–3300 | end vi.–vii. |
| 349. —— nemoralis, Linn. | ... | W | 2400 | end vi.–early viii. |
| 350. —— pratensis, Linn. | ... | W | –2100 | mid. vi.–early viii. |
| 351. —— trivialis, Linn. | ... | W | –2500 | mid. vi.–early viii. |
| 352. Glyceria fluitans, R. Br. | ... | ... | –900 | vii.–mid. ix. |
| 353. Festuca ovina, Linn. (with F. duriuscula, Linn.) | ... | W | –3300 | mid. vi.–early viii. |
| 354. —— rubra, Linn. | ... | W | –2800 | mid. vi.–vii. |
| 355. —— pratensis, Huds. | ... | W | –800 | mid. vi.–mid. viii. |
| 356. Bromus mollis, Linn. | ... | W | –800 | end vi.–vii. |
| 357. Lolium perenne, Linn. | ... | W | –900 | mid. vi.–mid. ix. |
| 358. Agropyrum repens, Beauv. | ... | W | –900 | end vi.–viii. |
| 359. Nardus stricta, Linn. | ... | W | –3000 | end v.–vii. |
| Coniferæ— | | | | |
| 360. Pinus sylvestris, Linn. | ... | W | –1800 | end v.–vi. |
| 361. Abies excelsa, Poir. | ... | W | –1700 | vi. |
| 362. Larix europæa, DC. | ... | W | –2200 | vi. |
| 363. Juniperus communis, Linn. (with J. nanus, Willd.) | ... | W | –2200 | mid. v.–vi. |

The above list contains among the self-maintaining species, 113 wind-fertilised flowers (W), 17 pollen flowers (Po), 25 of class A, 61 of class AB, 43 and 37 of classes B and B$^1$, 60 bee flowers (H), and 7 butterfly or moth flowers (F).

The Clova alpines are most numerous in the slightly specialised flowers, *e.g.* classes A and AB.

| | Lowland. | | Alpine. | | Total. |
|---|---|---|---|---|---|
| | No. | Per cent. | No. | Per cent. | |
| Class W | 91 | 80·53 | 22 | 19·47 | 113 |
| ,, Po | 15 | 88·24 | 2 | 11·76 | 17 |
| ,, A | 16 | 64·00 | 9 | 36·00 | 25 |
| ,, AB | 43 | 70·49 | 18 | 29·51 | 61 |
| ,, B | 33 | 76·75 | 10 | 23·25 | 43 |
| ,, B$^1$ | 28 | 75·68 | 9 | 24·32 | 37 |
| ,, H | 50 | 83·33 | 10 | 16·67 | 60 |
| ,, F | 6 | 85·71 | 1 | 14·29 | 7 |
| | 282 | | 81 | | 363 |

## DISTRIBUTION IN ALTITUDE.

We pass to the distribution of the flower-classes in altitude, and here, in preface, it is to be remarked that (i.) although alpines are common in the belt of 500 feet between 2000 and 2500 feet, and many do not descend below it: (ii.) although various lowland plants pass above 1000 feet without overpassing the belt between 1000 and 1500 feet; and (iii.) although the belt between 1500 and 2000 feet holds fewer species than the belt above or the belt below it,—the three belts of 500 feet between 1000 and 2500 feet are practically identical in the composition of their floras by flower-classes. This is so much the case that for simplicity we have grouped in the following statements the three belts into one of 1500 feet:—

Anemophilous flowers are proportionally most numerous above 2500 feet—

| | Anemophilous. | | Entomophilous. | | Total. |
|---|---|---|---|---|---|
| | No. | Per cent. | No. | Per cent. | |
| Above 2500 | 35 | 40·23 | 52 | 59·77 | 87 |
| 1000-2500 | 85 | 31·18 | 180 | 68·82 | 265 |
| Below 1000 | 94 | 31·55 | 204 | 68·45 | 298 |

The two tables which follow give the numbers and percentages of Entomophilous flowers of various classes.

TABLE I.—Number of Entomophilous Flowers of Various Classes.

| | Po | A | AB | B | B¹ | H | F | Total. |
|---|---|---|---|---|---|---|---|---|
| Above 2500 | 2 | 6 | 15 | 8 | 9 | 11 | 1 | 52 |
| 1000-2500 | 12 | 15 | 47 | 29 | 28 | 43 | 6 | 180 |
| Below 1000 | 16 | 21 | 44 | 35 | 31 | 51 | 6 | 204 |

TABLE II.—Percentage of Entomophilous Flowers of Various Classes.

| | Po | A | AB | B | B¹ | H | F |
|---|---|---|---|---|---|---|---|
| Above 2500 | 2·85 | 11·54 | 28·85 | 15·38 | 17·31 | 21·15 | 1·92 |
| 1000-2500 | 6·67 | 8·32 | 26·11 | 16·11 | 15·56 | 23·89 | 3·33 |
| Below 1000 | 7·84 | 10·29 | 21·57 | 17·16 | 15·20 | 25·00 | 2·94 |

The following Classes increase upwards—AB, B¹.
,, ,, downwards—Po, B, H.

In all our visits* to Clova, except the first two, we made a point of counting the individuals of the various species of insect which we saw visiting the flowers. We do not

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* VISITS TO CLOVA.

1894, July 5–9 (J. C. W. and I. H. B.). Weather unsettled.
1895, April 1–17 (J. C. W.). Snow at first covering all down to 1000 feet, gradually retreating up the hills; nights frosty. The preceding four months had been excep-

intend to give these observations here, reserving them for a later paper, but it is worth remark that out of the 17,306 recorded visitors 11,554 were short-tongued flies, and that the order of their flower selection was to—

| | |
|---|---|
| Class B[1] . . . . . | 4972 |
| „ AB . . . . . | 3018 |
| „ A . . . . . | 2253 |
| „ B . . . . . | 640 |
| „ Po . . . . . | 344 |
| Classes F and H (combined) . | 299 |

the remaining 7 went to class W.

Among the 363 self-maintaining species of the flora, 45 are annuals, 276 are herbs of more than one year's growth, 34 are shrubby, and 8 are trees. Many of the annuals are maintained by man indirectly, and out of them we consider 28 to be intrusions on the results of husbandry. It is very marked how the annuals decrease in number as we ascend the hills.

| | No. | Percentage. |
|---|---|---|
| Above 3000 * . . . | 0 | 0 |
| 2500–3000 . . . | 3 | 3·41 |
| 2000–2500 . . . | 10 | 4·93 |
| 1500–2000 . . . | 10 | 5·52 |
| 1000–1500 . . . | 11 | 5·56 |
| 500–1000 . . . | 45 | 15·10 |

These figures are very regular in sequence; and, if we deduct from the flora of the lowest zone the 35

* Given shelter, annuals may run higher; Buchanan White found Euphrasia almost at the top of the crags of Lochnagar ("Scottish Naturalist," viii. p. 340), but within our region there is no shelter above 3000 feet.

tionally cold, with very heavy falls of snow which blocked the roads in the glen for fourteen weeks.

June 14–July 8 (I. H. B.). Fine to unsettled.

July 5–23 (J. C. W.). Wet weather.

September 13–24 (I. H. B.). Fine weather.

1896, May 21–23 (J. C. W.). Unsettled; season early.

June 16–July 11 (I. H. B.); July 4–11 (J. C. W.). Fine to unsettled.

1897, May 18–27 (I. H. B.). Very fine; season late.

1898, May 7–16 (I. H. B.). Cold, with frequent snow showers; season late.

1899, June 10–19 (I. H. B.). Fine and warm.

July 24–26 (J. C. W.). Dull.

We can only regret that it has not been possible for us to pay a visit to Clova in August; with the exception of this month, and the close of the season in October, we have worked at the biology of Glen Clova in all phases of its vegetative activity.

plants which may well have been introduced, and from the 46 annuals of this zone the 28 introduced annuals, we find the percentage of those left to be 6·61.

### DISTRIBUTION IN SEASON.

We must turn to the seasonal variation and sum it up. In this connection we have used the dates of collection attached to specimens in the Kew and Cambridge Herbaria, in order to amplify our own data; in both herbaria Clova plants are abundant.

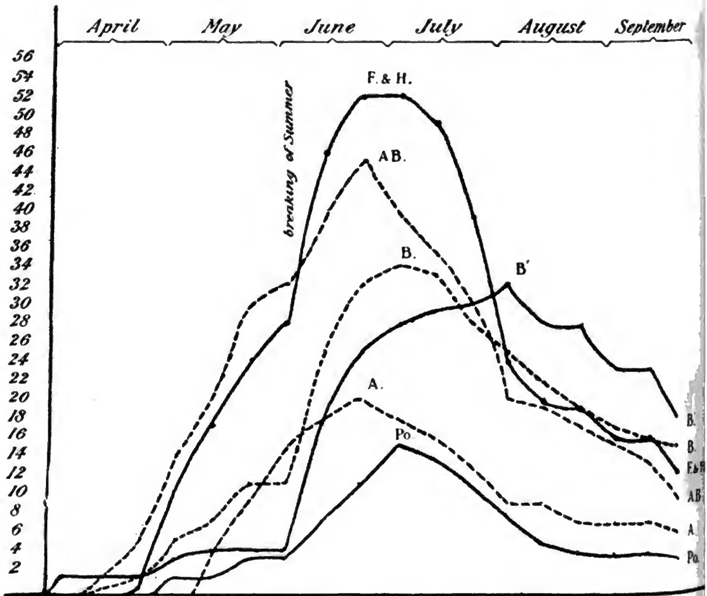


Table III. gives the actual figures recorded, and the curves opposite indicate graphically the early maxima of classes A and AB, the late maxima of B[1] and B, and the burst of flowering in the higher classes with which summer begins at the coming in of June. Those who know these hills will recognise that their own experience bears this out. In May, a flower here and there appears

on the hill sides or moors, such as *Saxifraga stellaris* or *Caltha palustris*, but in June is the beginning of the real flowering time.

TABLE III.—Seasonal Distribution, each month divided into three parts.

| | IV. | | | V. | | | VI. | | | VII. | | | VIII. | | | IX. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. |
| F & H . . . | ... | ... | 1 | 11 | 18 | 25 | 29 | 47 | 53 | 53 | 50 | 40 | 25 | 21 | 20 | 17 | 17 | 13 |
| B' . . . | 2 | 2 | 2 | 4 | 5 | 5 | 5 | 19 | 26 | 29 | 30 | 31 | 33 | 29 | 29 | 24 | 21 | 19 |
| B . . . | ... | 1 | 2 | 6 | 8 | 12 | 12 | 28 | 33 | 35 | 34 | 29 | 26 | 23 | 20 | 18 | 17 | 16 |
| AB . . . | ... | 2 | 6 | 15 | 21 | 31 | 33 | 41 | 46 | 40 | 36 | 31 | 23 | 22 | 20 | 16 | 14 | 10 |
| A . . . | ... | ... | ... | ... | 5 | 10 | 16 | 19 | 21 | 19 | 17 | 14 | 10 | 10 | 8 | 8 | 8 | 7 |
| Po . . . | ... | ... | ... | 2 | 2 | 4 | 4 | 8 | 12 | 16 | 15 | 12 | 9 | 6 | 5 | 5 | 5 | 4 |
| W . . . | 6 | 7 | 8 | 11 | 17 | 24 | 31 | 75 | 88 | 85 | 81 | 70 | 50 | 36 | 29 | 19 | 18 | 13 |
| All . . . | 8 | 12 | 19 | 49 | 76 | 111 | 130 | 237 | 279 | 277 | 263 | 227 | 176 | 147 | 131 | 107 | 103 | 82 |

Europe is almost annually visited on or about the 16th, 17th, and 18th of May by a short cold period. The Continent feels its effect more than Britain, but Britain is far from being beyond the spell of these "ice-saints." To its effect on the flowering of plants one writer has already called attention. It may possibly have something to do with these curves here produced, but we can offer no more than the bare suggestion.

The same breaking of summer is shown in the figures relating to anemophilous flowers which follow—

TABLE IV.—Seasonal Distribution of Anemophilous Plants.

| | IV. | | | V. | | | VI. | | | VII. | | | VIII. | | | IX. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. | Early. | Mid. | Late. |
| Deciduous trees and shrubs . | 5 | 5 | 6 | 4 | 3 | 2 | 4 | 4 | 3 | 1 | 1 | ... | ... | ... | ... | ... | ... | ... |
| Evergreen trees and shrubs . | ... | ... | ... | ... | 1 | 2 | 3 | 3 | 3 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Herbs, terrestrial . . . | 1 | 2 | 2 | 7 | 14 | 20 | 21 | 64 | 80 | 81 | 77 | 67 | 46 | 32 | 26 | 18 | 17 | 12 |
| ,, aquatic . . . | ... | ... | ... | ... | ... | ... | ... | 1 | 2 | 3 | 3 | 3 | 4 | 4 | 3 | 1 | 1 | 1 |
| | 6 | 7 | 8 | 11 | 18 | 24 | 31 | 75 | 88 | 85 | 81 | 70 | 50 | 36 | 20 | 19 | 18 | 13 |

We have divided Table IV. so as to show in what way the deciduous trees are the first of anemophilous plants to flower, aquatic herbs the last. Clarke and Robertson,* as well as others, have pointed out how much more readily the pollen may be borne from stamen to stigma on a leafless tree than when leaves are present to obstruct; and they point out how the deciduous trees flower in the van of others in North America as with us. The laws which rule the flowering of anemophilous plants are likely to be found of general application in temperate regions.

## SUMMARY AND CONCLUSION.

The Phanerogamic Flora of the Clova region contains 363 plants which maintain themselves under the present conditions. More than a quarter of the whole do not ascend the hills at all; about one-fifth pass to above 2500 feet. Species which are wind-fertilised, or have simple flowers of the classes A and AB, grow proportionally more numerous towards the hilltops. Blossoming, which begins about the commencement of April, does not increase regularly toward the height of summer, but species show a tendency to delay until May is out; between early and

* "American Naturalist," xxvii. p. 769, and xxix. p. 97.

mid June there is a rush of plants into flowering. In autumn, the flowering tails out until, in October, frosts and the first fall of snow close the season; the flowering periods that the frosts cut short are not of alpine but of lowland plants, and in a large measure of such weeds of fields and roadsides as owe their presence to man. Milton of Clova more than fifty years ago was a village of handloom weavers, who have now disappeared. H. C. Watson visited Clova in 1844 when, according to his manuscripts and herbarium now at Kew, he found more of the class of plants which are dependent on man than we have seen.

The strath of the Deeside, at Braemar, carries plants to higher levels than at Clova, so too the strath of Glen Muick; with this fact we are not further concerned than to remark that only in the straths of these glens is to be found the soil which encourages these plants to grow. The experience of the cultivator of Clova tells him that immediately he leaves the dried-up lake-beds of the valley, he finds only peat and stones.

Next, a word on the warmth of some of the glens. It is well known how valleys, running east and west, unless open to the winds, gather in summer a considerable amount of heat; such is especially the case with Glen Fiadh, where, on cliffs facing south, many of the plants we have observed reach their greatest elevation.

And lastly, it is not hard to see that where protection from the wind ceases, and the hillsides pass over into the moors, the flora changes in biological character more than at any other point. Here annuals disappear, classes Po and F almost disappear, and anemophilous flowers suddenly advance to forty per cent. of the zonal flora (they are 31·55 below 1000 feet, 31·98 between 1000 and 1500 feet, 32·78 between 1500 and 2000, and 31·19 between 2000 and 2500 feet). These changes are accompanied by a change in appearance of the vegetation evident to the eye, and make the 2500 feet contour line one of importance to us in considering the fertilisation of Clova flowers.

## THE TRACK OF HEREDITY IN PLANTS AND ANIMALS.

By J. BEARD, D.Sc.

(Read 9th January 1902.)

Owing mainly to the writings of Brooks, de Vries, Hertwig, Naegeli, H. Spencer, and, above all others, Galton and Weismann, the problems of heredity have occupied a prominent position in the scientific discussions of recent years.

The progress of research into the life-history of the cell, the structure and functions of the nucleus, the phenomena of cell-division, more especially those of the "ripening" of the "sexual products," have naturally played important parts in these. Indeed, so much has this been the case, that H. F. Osborn might well say "the study of heredity will ultimately centre around the structure and functions of the germ-cells."

It is not my intention to attempt the task of writing a history of these discussions and theories: what is proposed is merely to indicate the broad and obvious bearings of certain of my results, relating to the history of the germ-cells, on the general problem of heredity.

In order to obtain a clear insight into the process or processes by which, in a wide sense, germinal continuity, resulting in the phenomena of heredity, is brought to pass, it is a requisite postulate, that an uninterrupted and continuous panorama of the whole course of development from one generation to the next should be secured. Heredity must be dependent on some sort of germinal continuity; whether of a special germ-plasm in Weismann's sense, or a consequence of an uninterrupted sequence of germ-cells, or a result of an intracellular pangenesis, or something else.

In this way it comes to be a problem of embryology and development, and as such it falls within the province of the embryologist. This being so, is it not remarkable that the chain of germinal continuity should hitherto not have been completely grasped in any single case? From my researches on the germ-cells,[1] it is clear that hitherto no

[1] J. Beard, "The Morphological Continuity of the Germ-Cells in *Raja batis*." Anat. Anz. V. 18, pp. 465–485, 1900.

complete survey of the development from one generation to the next has really been made. One phenomenon in the Metazoan life-cycle has entirely eluded the observation of embryologists; or, if they have noted or recorded it, they have failed to realise its full significance. This is the formation of the primary germ-cells, with the epoch at which these appear upon the scene.

Their very early origin—before any trace of an embryo had been laid down—was long ago recorded in certain cases, among others, by Weismann, Buetschli, Grobben, Ritter, Metschnikoff, and O. Hertwig. But these very instances only serve to strengthen my contention; for in them the few primary germ-cells—from two to eight in number—were apparently so insignificant that their formation at a particular time seemed to be an incident of no moment; and its discovery, like many other important finds, was passed over, because no estimate could be set upon its value.

Long ago Nussbaum concluded that the germ-cells must differentiate themselves at a very early period, before there was any trace of histological differentiation in the embryonic foundation. But Weismann,[1] carrying with him practically all other zoologists,[2] has decidedly rejected this view; "because, as a matter of fact, the sexual cells of all plants and those of most animals do not separate themselves from the beginning from the somatic cells."

And this is just the question at issue! To allow the statement to pass unchallenged might be taken as a tacit admission of its accuracy, although every page of the present writing asserts its incorrectness. The passage was written more than fifteen years ago; much has happened in the meantime, and it may no longer represent Weismann's views. But the objection is recorded in the literature of embryology, and it requires refutation.

The argument contains two fallacies, and these rob it of

[1] A. Weismann, "Die Continuitaet des Keimplasma's," Jena, 1885, p. 44.

[2] Thus, for example, Oscar Hertwig ("Zeit-und Streitfragen der Biologie, Heft I.," p. 76, 1894). Here it is written, "Zweitens gehoeren die Geschlechtszellen ebenso gut zum Koerper eines Organismus, von welchem sie sogar oft den betraechtlichsten Theil, wie z. B, vielen Parasiten, ausmachen, wie jedes andere Gewebe, etc."

all force. Taking these in the order of their occurrence, the first is that the sexual cells of all plants do not separate themselves from the beginning from the somatic cells. Probably all the higher plants, the metaphyta, are here referred to, for in many of the lower plants all the cells might be regarded as potentially reproductive, or "sexual." In the higher plants the "sexual cells" do appear at a very early period in the sexual generation. The higher one ascends, the earlier is this epoch; for in the flowering plants, for instance, the life-span of the sexual generation, the gametophyte, is exceedingly short, and it is concerned solely with the differentiation of, and the provision for, the sexual cells. These latter certainly do not appear as such in the asexual generation or sporophyte, nor is it to be expected that they should. Were they to do so, the sporophyte would lose this character, and become a gametophyte. Moreover, even in the asexual generation, the sporophyte, the morphological continuity is unbroken, for in this the future germ-cells are represented by their direct ancestors, the one or more cells forming the apex.[1]

[1] Compare Noll's eloquent testimony in the following:—"*The Continuity of the Embryonic Substance.*—The vital capacity of the cells of the functioning permanent tissue is always limited in time—mostly, indeed, very closely so. Without limit, on the contrary, and never finding a natural close, the vital power of the embryonic substance is preserved. This it is which forms the growing points of the perennial plants, and from this, as Sachs first demonstrated, the growing points of the sexual progeny are directly derived through the substance of the germ-cells. This embryonic substance does not age; it produces new passing individuals, but it is permanently preserved in their progeny: it is always productive, always growing young and increasing. Thousands upon thousands of generations, which have arisen in the course of millions of years, were its products, but it lives on in the youngest generations with the power of giving origin to coming millions. The individual organism is transient, but its embryonic substance, which produces the mortal tissues, preserves itself imperishable, everlasting, and constant. Regarded from this standpoint, the differences in the duration of life between short and long-lived plants, between annual herbs and the thousands of years old giants of the plant-race, appear in another light. Out of the embryonic substance of that lime tree of Neustadt every year new leaves and buds form, but these remain in connection with the dying remains of structures of earlier years. In the annual plant, on the contrary, the embryonic substance separates itself every year in the embryo from the mortal remains, and forming new branches, leaves, and roots, becomes a completely new individual.

"At the basis of the old and well-known dictum of Harvey, 'omne

What Nussbaum rightly insisted upon was the early appearance of the germ-cells in the sexual generation of animals, *i.e.* in the embryo before this had undergone histological differentiation. In urging this Nussbaum really took up a very moderate attitude. To refute his argument from the botanical side, it is necessary to compare the conditions in the corresponding generations in the two kingdoms—that is, to place the embryo and the prothallus together, not the embryo and the sporophyte. It should also be pointed out that even now the early history of the germ-cells of "most animals" has as yet been very inadequately investigated. Where it has been traced back to the farthest possible point, there a very early origin has been invariably made out. This is now so in *Moina*, *Cyclops*, *Ascaris*, *Strongylus*, *Cecidomyia*, *Chironomus*, *Sagitta*, *Phalangium*, *Lernæa*, *Micrometrus*, Scorpions (Brauer), several insects (Heymons), some sponges (Maas), and Cephalopoda (V. Faussek), and, lastly, in *Pristiurus* (Rabl), *Scyllium*, and *Raja*.

Hitherto the apparent phenomena in the Vertebrata stood in the way. Here even a segmental origin of the "sexual cells" had been recorded in relatively late stages. This is, however, only one of the ever-recurring instances of the earliest observed appearance of a thing being taken to represent its first origin. This is only permissible in embryological research, when an earlier origin is absolutely out of question.

From a fair acquaintance with the embryological literature treating of the germ-cells and their origin, the writer must maintain that there is really no reliable evidence pointing to the very late appearance of the germ-cells in any single case. On the other hand, there is a steadily accumulating body of very strong testimony in favour of their very early separation off in many different divisions of the animal kingdom. Even the case of the HYDROID POLYPES cannot be cited in disproof, for Weismann's own

vivum ex ovo,' there thus already lay the continuity of the embryonic substance. This is, at the same time, in eternal youth and organic immortality the substance of the unicellular organisms, which, reproducing by fission, are used up in one another without residue."—F. NOLL, in Strassburger's "Lehrbuch der Botanik," 2te Aufl, 1895, pp. 208, 209.

great researches reveal not so much the origin of the germ-cells in these as their remarkable migrations.

In saying the foregoing in face of the known facts concerning *Moina*, the dipterous insects, etc., Weismann defined not only his own standpoint towards the question, but also that of most other zoologists. The exception meets with no favour, until it ceases to be such, and adapts itself to the rule. But "die Natur geht ihren Gang, und was uns als Ausnahme erscheint ist in der Regel." And this is so, simply because what we regard as the rule is often false, the real law being that with which the apparent exception conforms.

While only from two to eight primary germ-cells were found very early in the development of this or the other form; while, as in the higher animals, one could study the early development without seeing any germ-cells—their "segmental origin" even being witnessed at later periods—the good old rule, in plain language, the superstition, that the offspring was formed by the union of a small portion of each of its parents, seemed to be the only logical conclusion. Thus it happened that so great an investigator and thinker as Darwin could set up his provisional hypothesis of pangenesis.

When in one of the higher animals, the skate, the formation of a whole battalion of germ-cells is found to take place prior to the appearance of any trace of the embryo, a change comes over the scene: the apparent law and its exceptions exchange positions, with the consequent disappearance of the former.

In the life-cycle of the skate (including in this all that happens from the union of egg and sperm, until new eggs and sperms are formed) the origin of the germ-cells fills in so large a space as to overshadow completely everything else. For this reason the formation of an embryo may be described as a mere incident in the life-cycle.

Two primary germ-cells and five hundred and twelve are very different numbers. If the full significance of this should not be apparent, a glance at the diagrammatic representation of the life-cycle of the skate may serve to make it so. The diagram is, however, incorrect! In the portion showing the origin of the primary germ-cells, these

have only been drawn to six divisions, giving sixty-four. To exactly embrace the full significance of the discovery, the drawing ought to include three further divisions, yielding five hundred and twelve germ-cells at P.G.C.

That is to say, to accurately represent the conditions in embryo no. 454, for example, the diagram ought to be at P.G.C. eight times as wide as it is at present!

When I see in this diagram some of the results of twelve years of work, the reader will perhaps pardon me, if I linger to say something more concerning it and its origin. Some parts of it will be familiar to every embryologist, thanks to the work of Boveri, O. Hertwig, and others; the other and unfamiliar portions are my own.

Following out the full history of the diagram, I am carried back more than twelve years. As long ago as 1888 my researches on larval structures in fishes commenced. Their results in course of time carried the investigator in the direction of the recognition of an antithetic alternation of generations. Since that standpoint was attained, no facts adverse to it have been encountered. The doctrine has never been seriously attacked: it has been simply ignored. It has not as yet won many adherents: the truth never does at first. For myself, I have been content to follow out the inquiry, and from time to time, as opportunity offered, to glean a few more facts supporting this theory of development. During part of this period a watch has been kept for something equivalent to the formation of spore-mother-cells in the higher plants or Metaphyta, but in vain. Hitherto, as at length clearly recognised, the search had not been made in the right place.

The investigator is often the creature of circumstances. These in the present case brought about an investigation of the early history of the germ-cells without associating with this inquiry any ideas concerning spore-mother-cell-formation or alternation of generations.

Only when the work was practically ready for publication, and when a proper survey of the results had been obtained, by drawing them up in diagrammatic form, as shown in the table, the full force of the discovery became

apparent. The formation of the primary germ-cells in the skate—and in all probability in every other Metazoon—corresponds broadly to the genesis of spore-mother-cells on the asexual generation of a plant—the sporophyte.

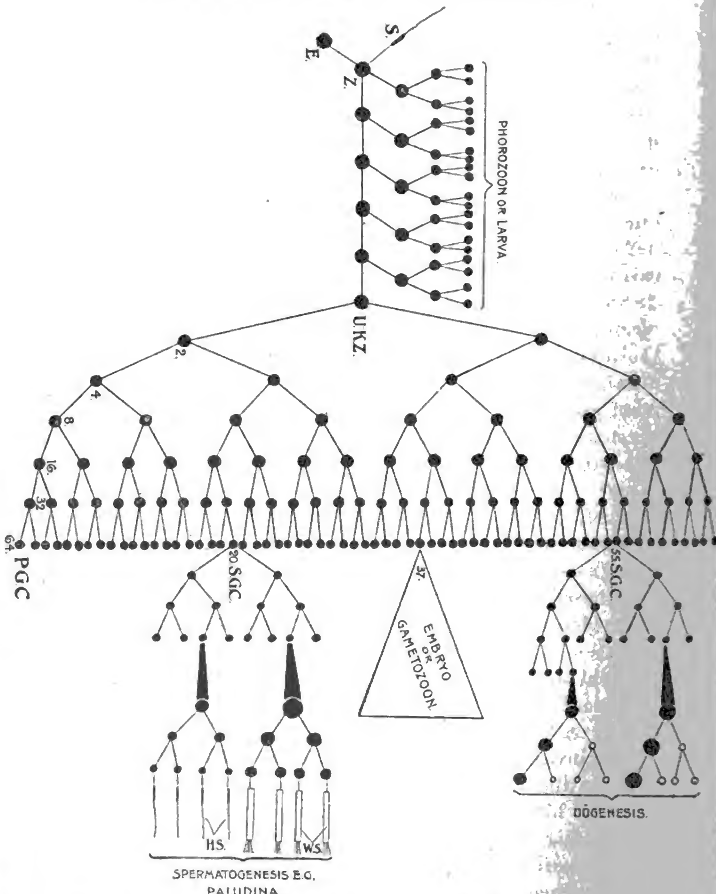


FIG. 1.—DIAGRAM OF THE LIFE-CYCLE OF THE SKATE (*Raja batis*).

With this recognition it becomes possible to compare together, so as to show their essential similarity, the

phenomena of the life-cycles of the Metazoa and Metaphyta.

In the same way the discovery of the formation of the primary germ-cells, and of the epoch of their coming into being, throw new and unexpected light on the course and nature of heredity.

These are the chief results of my work on the germ-cells; and, though other and doubtless important finds have been made, the latter sink into insignificance when placed beside the former.

Certain parts of the diagram have been adopted, as already stated, from the writings of other embryologists. This, however, has not been done without important modifications, for which the writer is alone responsible.

Originally, towards the close of last year (1900), Boveri's diagrams of oögenesis and spermatogenesis formed and filled in portions of the life-cycle. Doubts, however, arose as to their completeness, and the working out of the probable course of oögenesis in the skate finally resulted in the modifications here depicted. The first part of the figure, from the zygote Z, formed by the union of egg and sperm, to the primitive germ-cell U.K.Z. (the "Urkeimzelle" of German authors), is from Boveri's and Weismann's figures. In their diagrams, however, from Z to U.K.Z. marks what Weismann terms the "germinal track" (Keimbahn), and the products to the left of it are assumed to be cells of the embryo. As in the skate there is no possibility of the existence of any part of the embryo prior to the formation of U.K.Z., it is out of question that the said cells can be part of this. It is an assumption that they are parts of the embryo; for in *Ascaris megalocephala*, for instance, the form to which Boveri's identical diagram refers, it has never been established that directly from the cleavage of the fertilised egg the sexual generation or embryo takes its origin. The later history is here unknown. Indeed, it may be safely predicted that, when the facts become known, of the two primary germ-cells of *Ascaris*, formed by division of the cell U.K.Z., the one will be seen to form the embryo or

sexual generation, while the other will furnish its sexual products.[1]

It will doubtless be urged that on my part also it is an assumption that the cells to the left of the line Z to U.K.Z. give origin to the larva. In a sense this is true; but the one assumption is *prima facie* as good as the other, and on the further evidences to be adduced it is a good deal better.

From the existence of a transient nervous system, a blastoderm, and other evanescent structures, the conclusion was long ago arrived at that there was a larva or asexual generation in the life-cycle of the skate. From all the known facts of embryology such a larva cannot arise out of an embryo; it must precede an embryo. There is no embryo by the time the period P.G.C. is reached, the formation of such commencing here. Therefore, the first products of the cleavage, apart from the line leading to U.K.Z., must be the larva.

Evidence from another side will be found in, for instance, E. B. Wilson's published researches on the development of *Nereis*.[2]

There was some hesitation in the writer's mind as to the possibility of using Wilson's results in support of the view here presented as to the nature and destiny of the first cleavage products. A perusal of the lecture cited below served to remove this. His work of 1892 and his

[1] In *Ascaris megalocephala*, it is at least possible that the primitive germ-cell is separated off at the fourth cleavage instead of at the fifth. The latter cleavage would then divide the primitive germ-cell into two primary germ-cells, of which the one would go to form the embryo, and the other would represent the "sexual products." If this be the correct interpretation of the conditions in *Ascaris*—a point upon which I do not venture to express an opinion—the subsequent division of the cell, regarded by Boveri and others as the primitive germ-cell, would correspond to the formation of secondary germ-cells in *Raja*; that is, the parent cell would be a primary germ-cell.

Regarding the life-history of such a Nematode as *Ascaris megalocephala*, what is written above concerning the part unknown needs no justification. But if it be imagined possible that here, directly from the fertilised egg, the sexual form as it occurs in the horse can arise, a reference to the account of Maupas' results of investigations into the life-histories of a number of Nematoda will dissolve the illusion. (*Vide* "Arch. Zool. Exper.," v. 8, pp. 463–624, 11 pl., 1900.)

[2] E. B. Wilson, "The Cell-Lineage of *Nereis*," "Jour. of Morph.," vol. vi., pp. 361–480, 1892. "Cell-Lineage and Ancestral Reminiscence," "Wood's Holl Biol. Lectures," pp. 21–42, 1898 (published 1899).

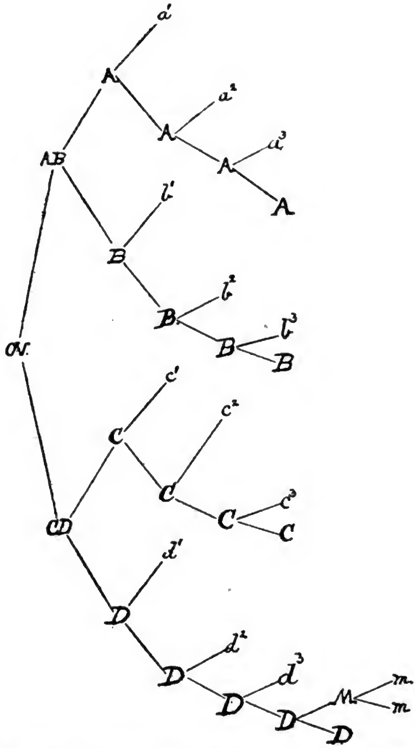


FIG. 2.—EGG-CLEAVAGE OF NEREIS (*after* E. B. Wilson.)

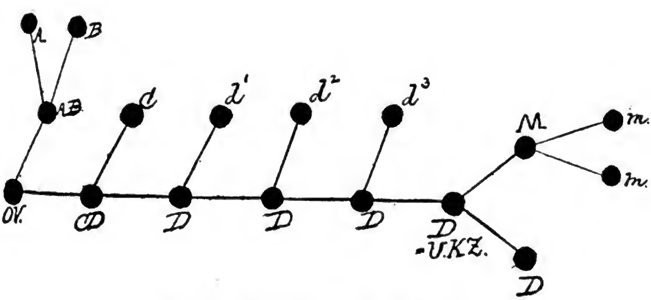


FIG 3.—EGG-CLEAVAGE OF NEREIS.

more recent results must be taken together, for Wilson himself has seen reason to alter his earlier interpretation in some slight but important respects. These amendments are exactly of the kind required for my reading of his table of the cell-lineage.

In Fig. 2. Wilson's table, so far as it concerns us, is reproduced, and in Fig. 3 the same results are shown after the manner of Boveri's figure, or the part of my diagram from Z to U.K.Z.

The main difficulty of the writer in his reading of Wilson's diagram has hitherto been the supposed destiny of the cell $d^2 = x$. From p. 30 of his recent lecture it may be gathered that the author, following the finds of Lillie in *Unio* now looks upon this cell $x$ as representing a larval mesoderm-cell. This is exactly the fate it ought to have, for, as we have seen, everything to the left of the line Z to U.K.Z. must belong to the phorozoon or larva.

The primitive germ-cell has not yet been identified in Annelida. From my interpretation of Wilson's finds it would appear to arise in *Nereis* at the fifth cleavage as the cell in Fig. 3 labelled D = U.K.Z. This then divides into (two primary germ-cells) D and M. M is the primary mesoderm-cell or somatoblast of various authors. Its division initiates the period of bilateral cleavage. Its two products form the two "mesoderm-bands." In contradistinction to other authors, the writer must maintain the opinion that M is a primary germ-cell, and that it gives rise to the whole of the sexual generation, in this case the worm. In this connection it may be of interest to recall the circumstance that long ago Hatschek expressed the view that the two products of M, the well-known "pole-cells" of Hatschek, were originally eggs.[1] This suggestion has been criticised by Kleinenberg.

If the pole-mesoderm-cells be not eggs, they at least arise by the division of the next thing to an egg, a primary germ-cell.

In *Nereis* the remaining primary germ-cell D comes to

[1] Wilson approves of E. Meyer's amendment of Hatschek's view into a correspondence of the mesodermal bands with paired gonads. In the sense indicated above, there is much to be said in favour of Hatschek's interpretation; the other idea is wildly impossible.

form part of the hypoblast. There is no difficulty about this. Even in the skate many of the primary germ-cells may for a time lie in the hypoblast, but they do not give rise to hypoblastic cells. As Wilson remarks, "the ultimate court of appeal . . . lies in the fate of the cells" (*loc. cit.* 2, p. 41).

Another apparent difficulty, more especially to the view of the complete similarity and equivalence of the primary germ-cells, would be that sometimes the embryonic cell may perhaps exceed the primary germ-cells in size. As an instance, that D and M mentioned above may be of different sizes. But this very difference in size may serve to explain why some particular primary germ-cell is chosen to form an embryo instead of some other. Position alone cannot always be at the bottom of this. In the skate, for example, the embryo does not invariably begin to arise at one certain spot upon the blastoderm. It may be that the stimulus afforded by an extra amount of food-yolk may have much to do with the initiation of development.

Very suggestive and significant, in the light of my results in the skate, are the following passages from E. B. Wilson's memoir on the "Cell-Lineage of *Nereis.*" Statements equally pregnant with meaning will be found in various parts of Eisig's work on the development of Capitella ("Mitt. a. d. Zool. Stat. zu Neapel," v. 13, pp. 1–292, 1898).

On page 393 Wilson writes: "*Transition to the Bilateral Period.*—As far as the development of the permanent organs is concerned, the transition from the spiral to the bilateral type of development is remarkably abrupt."

It may be mentioned that, at the close of the spiral period, there are, according to Wilson, thirty-eight blastomeres present. That is to say, the majority of them are products of the fifth cleavage.

On page 444 he asks: "What is the significance of the spiral and bilateral forms of cleavage, and where lie the causes that determine the transformation of the one into the other?" Further on he writes: "The most striking feature in the cleavage, and the one on which the entire discussion may be made to turn, is the sudden

appearance of bilateral symmetry in the cleavage. The meaning of the bilateral cleavages in themselves is perfectly obvious. They are the forerunners of the bilateral arrangement of parts in the adult; and, as such, their explanation belongs to the general problem of bilateral symmetry, which need not be considered here. The all-important point is that the bilaterality does not appear at the beginning of development. It appears only at a comparatively late stage, and by a change so abrupt and striking as to possess an absolutely dramatic interest." And so on. I refrain from further quotation, because Wilson's work contains no real solution of the problem.

To my mind the solution was lacking, because, on the one hand, it was not recognised that the mode of development was by means of an alternation of generations; and, on the other, the history of the primary germ-cells in *Nereis* was, and is, unknown.

If the reader will compare Wilson's statements with the course of development depicted in my diagram—not forgetting, I trust, that the latter is a diagram, and nothing more—the meaning of the spiral cleavage and of the sudden and abrupt change, of which Wilson speaks, may become apparent.

The apical mode of growth, so characteristic of the early formation of the asexual generation in both plants and animals, and which is retained for the whole life-span of the sporophyte of plants, might also be described as spiral. Indeed, it is so regarded and described by botanists. Then with the cutting off of the connection between the primitive germ-cell and the asexual generation or phorozoon we witness the practical end[1] of the spiral mode of cleavage, and the commencement of the bilateral period. With this the formation of the primary germ-cells is connected; following the genesis of these a start is made in the unfolding of the embryo.

In this way my diagram gives a general interpretation of Wilson's finds, not to mention those of other observers.

[1] The practical end, but not the actual termination; for, as Wilson points out (p. 393), "it is only in the peculiar changes involved in the formation a larval organ, the prototroch, that the spiral form of division overlaps the bilateral period."

And thus the phenomena observed in the development of *Nereis* are seen to be due to an antithetic alternation of generations, where the asexual generation arises in a spiral or apical manner, where the sexual generation is characterised by a bilateral mode of formation, and, lastly, where one may predict the formation of a primitive germ-cell, and of primary germ-cells from this, between the two generations—that is to say, prior to the development of the sexual generation.

In the course of more than twelve years spent in the attempt to elucidate the mode of Metazoan development, at various times many things have seemed inexplicable; but wherever their history has been discovered, they have been found to fit into an antithetic alternation of generations, and into nothing else.

If Wilson's finds be not based in such an alternation, but be in connection with a "direct" mode of development, they seem to me to include facts which will never be explicable, for such a roundabout kind of development can hardly be termed "direct." Or shall we "explain" and describe them as the development of the Scyphozoa is explained and described in almost all the current text-books, by the omission of any reference to the main portion of the asexual generation, the stolon, discovered by Sars?[1]

Such a course may simplify matters, but it hardly makes for the discovery of the facts of nature!

Reverting to the diagram of the life-cycle of the skate, I consider it to be possible at present only by comparison and induction to show the fate of the cells to the left of the "germinal track" as far as U.K.Z., the primitive germ-cell. The comparison with other cases only goes to show its correctness, and, I am convinced, the number of such will increase in the proportion as the study of cell-lineage, so ably established by Whitman, Mark, and E. B. Wilson, replaces the pursuit of the three sacred layers of embryologists.

Up to the point U.K.Z. of my diagram the germinal track in Weismann's sense lies apparently in the larva. It may be objected that in making this substitution the

[1] M. Sars. "Ueber die Entwicklung der *Medusa aurita* und *Cyanea capillata*." "Arch. f. Naturgesch," vol. 7, 1841.

embryo has been displaced, in order to establish a more or less problematical larva, and that the germinal track is here somatic. The reply to this is, that the cell U.K.Z. and its immediate ancestors never form part of the larva, and that the period[1] from Z to U.K.Z.—no matter how long it be, whether four generations or four thousand—is marked by a mode of growth and cell-division, conspicuous by absence in other parts of the diagram.[2]

This statement requires both elucidation and emphasis.

The mode of growth of the sphorophyte in plants is essentially apical, that is to say, wherever there is an apex there are always one or more apical cells, which by their division give off products towards the centre.

In the sexual generation of a Metazoon the mode of growth differs *in toto* from this; for here all the products ultimately undergo differentiation, and embryonic or germ-material, corresponding to apical cells, has no existence. The older embryologists of the first half of the nineteenth century thought differently, and some pathologists still cling to their views, but these have no shadow of foundation in fact.

The initial mode of growth and formation of the asexual generation or larva in animals—an organism never of a very high degree of organisation—is entirely comparable to that of the sporophyte. As in simple cases of the latter, there is here one "apical cell" which never itself forms part of the larva, but instead thereof gives off into the latter a greater or less number of products, while retaining its own unicellular or Protozoan character. Nor would the conditions be altered if there were several growing points, as generally met with among the Hydrozoa.[3]

[1] In the skate this period includes *more than* five mitoses, probably ten.

[2] Spemann has already compared the mode of origin of the first cleavage products in Nematodes, more especially in *Strongylus*, to the apical mode of growth in the sporophyte of a plant. He notes that the cell along the line Z–U.K.Z. in my diagram acts as though it were an apical cell of a sporophyte. (H. Spemann, "Die Entwicklung von *Strongylus paradoxus*," "Zool. Jahrb. Morph. Abtheil." vol. 8, p. 304, 1894–95.

[3] It should be mentioned that de Vries and Weismann have already noted the resemblance in mode of growth between the sporophyte and the colonial Hydrozoa. Many of the latter also possess the indefinite

It may be objected that whereas the early cleavage of *Nereis*, *Ascaris*, etc., is spiral, in the Vertebrata, such as the skate, it is bilateral. The objection would not, I think, be a valid one. The meaning of such a bilateral cleavage in the early development—assuming it to exist—would simply be that there were two spirals instead of one, and possibly two primitive germ-cells. For various reasons I regard the actual larva or phorozoon of the skate as at the basis very like the tadpole larva of Ascidians. Indeed, I would go further, and, following the example of Roule with his classification of certain Invertebrate groups, as "Trochozoa," by their asexual generation of larva, so also in the tadpole-like larva of the Ascidians I would see—not the Vertebrate relation of many embryologists—but the like or even homologous asexual generation of Ascidians, Amphioxus, and the true Vertebrata.

Returning to the diagram. Sooner or later upon the larva the primitive germ-cell enters into activity. It may divide before the larva or phorozoon is properly differentiated, as nowadays is certainly the case in many instances, or, theoretically, its divisions may happen at a later period. These divisions, however, must precede the formation of the embryo or sexual generation.

In the skate the divisions of the primitive germ-cell, which give birth to the primary germ-cells, take place before the larva or phorozoon is fully differentiated, and, of course, before there is any trace of the embryo.

For reasons to be fully given in my memoir on the germ-cells, the divison of U.K.Z. the primitive germ-cell, is considered to go back to about the tenth cleavage products, and in the skate there are either eight or nine divisions.

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unrestricted power of growth so characteristic of the sporophyte of the higher plants. As a rule the asexual generations of the higher Metazoa do not exhibit this faculty. They rarely obtain a chance of showing it, for it is their usual fate to undergo early suppression by the sexual generation. When, as happens sometimes in cases of abortion in the human subject, the embryo is got rid of prior to the critical period, or, at anyrate, before the asexual generation has here been suppressed, the latter may go on growing indefinitely, if left in the uterus. I refer, of course, to the unrestricted and pernicious growth of the chorion when left in the womb after an abortion.

The publication of the present writing has been delayed for several months, in order that time might be gained for the tabulation and counting of the primary germ-cells in a series of embryos. This has now (March 1901) been done in eighteen embryos of *Raja batis*, and in eight of *Scyllium canicula.*

The number of primary germ-cells in the embryology of *Raja batis* may be taken at 256 in the male, and 512 in the female. It may be added that the number appears to be much smaller in *Rana esculenta*, and in *Petromyzon planeri.* In the former eight, and in the latter thirty-two, primary germ-cells would seem to arise. These latter numbers have not yet been confirmed on a material large enough to afford any certainty of their correctness.

The division of the primitive germ-cell into primary germ-cells is a well-marked epoch in the life-cycle, and one of the greatest possible moment. Hitherto its import has been overlooked by every embryologist, and the record of it is now made for the first time as the result of my work.

From every point of view it is as important as the phenomena of maturation; and probably its essential necessity in development will not need to wait long for ample recognition.

The number of the products of the primitive germ-cell is very large in the skate—as many as 512. But it must be pointed out that this number furnishes no criterion for other animals. There may be cases in which it is larger, though, I imagine, the occurrence of many such is unlikely. Undoubtedly there are instances in which it is much smaller; and probably these are well represented among the Invertebrata. In short, it may be as low as two; but as the sexual generation or embryo must arise from one product, and as this must contain some sexual elements, it can never be lower than two. In other words, the primitive germ-cell must divide at least once, yielding two primary germ-cells, of which one will give rise to the embryo, and the other will supply the "sexual products." Apparently it divides once in *Cyclops* and *Ascaris megalocephala*, twice in *Cecidomyia*, and thrice in *Chironomus.*

In other chapters of my work, the essential similarity

—the equivalence of all the primary germ-cells, whether their number be 2, 16, 128, 512, or anything else—has been insisted upon. The point is one of the utmost importance, and, therefore, it may be well to once more briefly indicate the grounds for the conclusion.

All the primary germ-cells have the same ancestry from the primitive germ-cell. One of them forms the embryo; and there is nothing to show that this one differs in any respect from its sister cells.[1] If two primary germ-cells undergo independent development on a blastoderm, the result is, and must be, the production of like-twins. The dermoid cysts or embryomas of Wilms are, as this able investigator has established, rudimentary embryos. These abnormal embryos must have taken their origin from persistent primary germ-cells; and the development of an embryoma is embryologically the abnormal formation of a twin, identical with the embryo.

The likeness of all the primary germ-cells is certain, or almost so; absolutely nothing suggests unlikeness among them. This essential identity or equivalence of all the primary germ-cells is immensely important from the point of view of heredity. This will be quite obvious.

It is it, and it alone, which permits of the handing down of the characters of one generation to future generations. It is the very basis of heredity. The formation of like primary germ-cells, and their essential similarity or equivalence, show how, in sexual reproduction, the offspring resemble their "parents," while differing from them. The likeness in the primary germ-cells leads to likeness in the offspring; and along with this unlikeness is bound to come in. For the primary germ-cells themselves give rise to secondary germ-cells, which have lost their powers of independent development. It is these, and these only, as a rule, which are present in the finished embryo. They and their progeny are never capable of independent develop-

[1] In *Strongylus* Spemann has commented upon the equivalence of what he terms the primitive germ-cell and the primitive mesoderm-cell; indeed, he speaks of them as "Geschwisterkind," or cousins (Zool. Jahrb., Morph. Abth." vol. 8, p. 313). His primitive germ-cell is, however, a primary germ-cell; and the true primitive germ-cell is that from which the two cells compared together took their birth

ment;[1] but it is their destiny to go through the process of reduction of chromosomes, with the ensuing formation of "sexual products" (or gametes), eggs, and spermatozoa. Here, as is of course now generally recognised, unlikeness enters. Although the egg, or sperm, traces its long ancestry to one of a certain set of primary germ-cells, of which one also gave rise to the "embryo," or form, whose "offspring"—according to social and commonly accepted ideas—the egg or sperm itself was, this said egg or sperm unites with another sperm or egg, the offspring of a different individual, which in its turn, with its reproductive elements, traces a similar origin and ancestry from another set of primary germ-cells. With the union the new cycle begins.

It is thus, that the formation of primary germ-cells underlies the fundamental facts of heredity, and explains these. And it is thus, without their knowing it, that the formation of primary germ-cells at a certain epoch of the development, prior to the production of the embryo, is the real basis of Weismann's finds in heredity, and, to a still greater degree, of those associated with the name of Galton.

The application in detail of the results to the phenomena of heredity is beyond the scope of my researches. To indicate the way may suffice.

Galton has been led by his studies and researches on inheritance to what is known as Galton's law.[2] According to this law, "the two parents between them contribute on the average one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter, or each of them one-sixteenth, and so on; the sum of the series—$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} +$ etc., being equal to 1, as it should be. It is a property of this infinite series that each term is equal to the sum of all those that follow, thus—$\frac{1}{2} = \frac{1}{4} + \frac{1}{8} + \frac{1}{16} +$ etc.; $\frac{1}{4} = \frac{1}{8} + \frac{1}{16} +$ etc., and so on. The prepotencies or subpotencies of particular ancestors, in any

[1] In the Vertebrata.

[2] Francis Galton: "The average Contribution of each several Ancestor to the total Heritage of the Offspring."—"Proc. Roy. Soc., Lond.," vol. 61, pp. 401–408, 1897.

given pedigree, are eliminated by a law that deals only with average contributions, and the varying prepotencies of sex in respect to different qualities are also presumably eliminated."

Assuming for the moment the correctness of this, its embryological basis is furnished by the formation, etc., of the primary germ-cells. The germ-cells in any embryo, possessing from their mode of formation like qualities, and having these and the like ancestry with that which formed the embryo, these qualities are necessarily halved at the following determination of sex and reduction. At the close of this halving the "parental" qualities can embryologically, under Galton's law, only be represented by at most one-half, or one-quarter for each "parent," and so on for each preceding generation; for in these also primary germ-cells of like characters were formed, of which one gave rise to an embryo in every case.

The line of ancestry is, of course, from and through these germ-cells, and never from the embryo or sexual generation of a preceding generation.

But as the germ-cells associated with any given embryo are all of like characters among themselves (including that from which the embryo arises) on the production of eggs and sperms, and the subsequent union of these with other sexual products, the result is the same as if the line of ancestry had been through the embryo, so far, at anyrate, as the ancestral characters are concerned. According to Galton, the parental qualities are at most represented in their progeny by $\frac{1}{2}$ $(\frac{1}{4}+\frac{1}{4})$.

In the same way, and because between offspring and grandparent there are two sets of germ-cells (in addition to those still immature in the offspring) and two reductions, the grandparental portions taken together can only be half of the parental portions taken together, that is to say, $\frac{1}{4}$, and so on through any number of generations. It will be quite unnecessary to carry out the examination further, for study of the diagram will make evident the light it throws from the embryological side on Galton's law, and how it furnishes this law with its basis in the facts of development.

In his book on the "Germplasm" (English edition, p. 257), Weismann has adversely criticised Galton's law. His

objections would be valid in cases where in-breeding had taken place; for Galton's law can only hold good if no in-breeding occur, and if none have happened.[1] This law really demands that there shall be no in-breeding.

But there is another aspect of Galton's law, and this arises from the following embryological facts. The reduction of chromosomes was probably, in its origin, merely an undoing of the previous union, and even now it is not the halving of a unit, but of *two* such. Therefore, it is not a reversion to half cells or half entities or individualities, but to whole ones. From this it follows, that at fertilisation we have to deal with the union of two individualities—of two complete lines of ancestry. The union of these is continued in the primary germ-cells, as evidenced by their duplicated nuclei, until the initiation at least of the ensuing determination of sex, and the united lines are broken up in two separate complete lines, not necessarily identical (like two strings of many-coloured beads) with the original two at the ensuing sex-determination and reduction.[2]

All along the line, from the fertilised egg to that primary germ-cell which unfolds as an embryo, this duplication is evident, and, of course, it must at first be in this cell too. As I have recognised in lectures, there must be a competition between the two components of the duplicated nucleus when development begins.[3] This will be such, that of the

[1] W. K. Brooks has already drawn attention to this matter. He points out that Galton's theory demands absence of relationship among all the ancestors. He then goes on to show that, in the case of three persons living on a small island, their known ancestry goes back seven to eight generations. The maximum number of distinct ancestors for all three persons together should be 1146, according to Brooks. Of these, 452 are recorded, but these are not 452 distinct persons, being, in fact, only 149. ("The Foundations of Zoology," pp. 143–145.)

[2] A further discussion of this matter will be found in a memoir upon the Determination of Sex, now in the press (*vide* "Zool. Jahrb. Morph. Abtheil., 1902").

[3] Haecker has quite recently referred to this in the following words:—"Eine aehnliche Concurrenz kommt vielleicht auch in den Bildern aus den Gonadanlagen von Diaptomus zum Ausdruck, und wuerde fuer das Verstaendniss mancher Vererbungserscheinungen (Dominiren des einen Elters) von Bedeutung sein." ("Anat. Anz.," vol. 20, p. 451.)

I make no comment whatever upon the foregoing, but leave it to the reader to determine the extent of the agreement between Haecker's brief and vague statement and the ideas and conclusions developed in the text of the present writing.

total nuclear constituents, which together make up the inherited characters of the two lines, one-half must be suppressed, or remain latent, in the development. If these characters be symbolised by the letters of the alphabet in such a way that the first half of these represent the characters of the one line, the second half those of the other, in the development of the embryo only half of this total can be made use of. Where one letter drops out, its place is occupied by the corresponding letter of the other half of the alphabet. In this way the phenomena of prepotency of a parent or ancestor become somewhat more comprehensible.

On p. 257 of the "Germplasm" Weismann writes: "It is evidently more than inaccurate to fix the limit of the hereditary power, as is done by animal-breeders, of a parent at $\frac{1}{2}$, of a grandparent at $\frac{1}{4}$, etc." To the writer there would appear to be more correctness in doing this than in limiting it to half this amount, as is done by Galton. Owing to the nuclear duplication referred to above, and the evidences afforded by it and other factors, as to the union of two individualities and two complete lines of ancestry, it seems to the writer that Galton's formula should be represented by something different.

The total inheritance would be—

$$\tfrac{1}{2}(\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}+\text{etc.}+\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}+\text{etc}).$$

In the formula,[1] as thus written, the results obtained by breeders find their full recognition.

Before leaving the subject, let me briefly indicate how the diagram elucidates the phenomena of in-breeding. In ordinary sexual reproduction in nature a set of primary germ-cells, exactly like those of a given case, even those of a given ancestor, can never reappear. This is clear from the law of reduction, which in succeeding generations is always leading further away from the particular ancestor. But with in-breeding along two closely allied lines, and by their final union, it may ultimately be possible to approach the qualities of a given ancestor, though probably mathematically an exact result is unobtainable.

The theory of heredity, outlined in preceding pages, has

[1] Mathematically, dealing with abstract numbers only, this formula is at the basis identical with that of Galton; but, as the factors are characters, not abstract numbers, this is not the case.

little or nothing in common with previous ones. Underlying it is something more than a mere morphological continuity of germ-cells. From its nature it might be termed "the understudy-theory of heredity." Given in a certain life-history the period of formation of the primary germ-cells. Of these let there be for simplicity but two, A and $A^1$. On one of these falls the lot of developing into an embryo. To which of the two this happens is not of consequence for the argument. In all its essential characters the remaining primary germ-cell (whose immediate destiny it is to become the founder of the "sexual products" of the said embryo) is the exact counterpart of the developing one. So much so is this the case, that if both form embryos, these are like-twins.

In the ancestry neither of the primary germ-cells A and $A^1$ had ever been a Metazoan; neither they nor their ancestors had ever formed parts of a Metazoan body. But their ancestry is continuous with a long line of germ-cells, and at regular intervals these were exactly like certain sister-cells, which did develop and form embryos. Although the cell $A^1$ does not itself give rise to an embryo, it retains for itself and for all its immediate progeny the properties of A, those characters which, were it or its progeny to develop, would make it or them like-twins with A.

In the drama of heredity there are always understudies, which for a certain essential period are endowed with all the identical properties of that germ-cell from which the player arises. These understudies, the primary germ-cells, are never employed upon the stage as such—except in instances of like-twins—but some of them, in new guises and after new conjugations, are the immediate ancestors of those which become the acting characters in new scenes of the cyclical drama of life.

We now pass to the consideration of the primary germ-cells as the equivalents of the spore-mother-cells of plants. The theory of an antithetic alternation of generations as the basis of Metazoan development postulates something resembling the formation of spore-mother-cells in plants. It is clear that the final reduction of chromosomes has been deferred to a later portion of the life-cycle in Metazoa

as compared with plants; and this fact was insisted upon some years ago by J. A. Murray and myself.[1]

At that time we compared the two modes of development in tabular form, and we postulated the formation of the embryo upon the asexual generation or larva from a spore-mother-cell. Certain facts supporting this view were cited, including E. B. Wilson's teloblasts of the earthworm, which must be derivable from one cell. Finally, the spore-mother-cells have appeared in the primary germ-cells of the present research.

REVISED COMPARISON OF METAZOAN AND METAPHYTIC LIFE-CYCLES.

| | *Metazoon.* | *Metaphyte.* |
|---|---|---|
| Asexual generation. | zygote (2n) | zygote (2n) |
| | "larva" or phorozoon (2n) | sporophyte (2n) |
| | formation of primitive germ-cell (2n) | formation of primitive spore-mother-cell (2n) |
| | formation of primary germ-cells (2n) | formation of spore-mother-cells (2n), probable determination of sex and reduction |
| | "apospory" (reduction postponed) | spore-formation |
| Sexual generation. | primary germ-cells (2n) | spores (1n) |
| | initiation of determination of sex | |
| | origin of embryo or gametozoon from one primary germ-cell, inclusion of rest in gametozoon (2n) | origin of gametophyte from one spore (1n) |
| | end of determination of sex, and reduction of chromosomes | |
| | ripening of germ-cells | ripening of germ-cells, reduction previously effected |
| | spermatozoon (1n) egg (1n) | male gamete (1n) female gamete (1n) |
| | zygote (2n) | zygote (2n) |

In the above table "n" equals the number of chromosomes prior to the duplication ("2n") at conjunction—that is, fertilisation.

*N.B.*—Although the primary germ-cells and the spores are shown in the table in the same line, they are not equivalent. The former correspond to the spore-mother-cells.

[1] J. Beard and J. A. Murray: "On the Phenomena of Reproduction in Animals and Plants."—"Anat. Anz.," vol. xi., pp. 234–255, and also in "Ann. of Botany," vol. ix., pp. 441–468. 1895.

In 1895 the writer was not sufficiently sanguine to believe it possible that at present the embryo would be found to arise in any case from such a spore-mother-cell. Only its formation at some time in the past from a spore-mother-cell was spoken of, because the facts of development at that time known seemed to point to its origin from at least a few cells.

And, moreover, everything then seemed to go to prove the production of the "sexual organs," *i.e.* the germ-cells, by the embryo itself. Such was the belief of almost every embryologist, and there appeared little or no reason for doubting its correctness.

The effect of these two factors was to bar further progress in that direction, at anyrate for a time. In face of the apparent facts, I confess that it was impossible to foresee how the formation of the spore-mother-cell was effected, with the natural result that only its former existence, *i.e.* in past times, was suggested. Moreover, there was not the slightest suspicion in my mind or Murray's that the germ-cells had anything to do with the matter.

It is possibly a humiliating confession to make, but it is quite true, that I was never able to conceive how Nature could carry out this formation of a spore-mother-cell and of the embryo from the latter, until my researches had revealed how she actually accomplished it. No one could have been more astonished than the writer at the revelation. Never had it for a moment been imagined that the germ-cells themselves would play the part they actually do in the life-drama of an antithetic alternation of generations. Only when the work was practically complete and ready for publication was it seen that the missing link in the alternation had been discovered in the primary germ-cells and in the epoch of their formation.

I hardly feel called upon to prove that the primary germ-cells do represent spore-mother-cells. If each of them were to undergo a reduction with the subsequent production of four "spores," and if then each animal spore were to develop into an organism, we should have the exact equivalent of the gametophyte of one of the higher plants.

Instead thereof they remain together, and only one

becomes sterilised to form a sexual individual or gametozoon. Their remaining together, and the continued and progressive amplification of the gametozoon in course of ages, have naturally deferred their ripenings, sex-determinations, and reductions to later and later periods. It is obvious that this could easily be effected by starving them, but this may not have been Nature's method of delaying their ripenings. A potent factor has probably been delay in the period of the determination of sex.

In the higher plants it is the spores, whose name is legion; while the "sexual cells," eggs and sperms, are few and far between. In animals the "sexual cells" exhibit the reverse condition, corresponding in their multitude to the spores of plants; while, as we at length know, the spore-mother-cells—there are no spores in the Metazoa—are not very numerous, being represented in some cases by but one cell in addition to that which forms the sexual generation.

Why this difference?[1] In the embryo-sac of *Pinus*, which is the gametophyte, there are only four germ-cells. In the corresponding structure in flowering plants there are perhaps three, or at most six; while, as is well known, the male gametophyte of a flowering plant is represented by one or two vegetative cells and one or two germ-cells.

No Metazoan sexual generation has so small and scant an endowment as these, while such an animal may contain and harbour a number of germ-cells thousands of times greater.

The difference is solely due to the different procedure adopted at the formation of the primary germ-cells or spore-mother-cells. The plan carried out in animals has been such as to favour and foster the ever greater and greater amplification of the sexual generation. In plants, as elsewhere already insisted, the reverse is the case. Here the asexual generation has undergone increased amplification without ever being able to attain any very

[1] "Zu vielen Tausenden zaehlen die vegetativ erzeugten Sporen, welche ein einziges Farnblatt ausstreut. Bei der geschlechtlichen Fortpflanzung der folgenden Generation wird dagegen von einem Prothallium selten mehr als ein neues Einzelwesen gebildet, etc."—F. Noll, in Strasburger's "Lehrbuch der Botanik," 2 te Aufl., 1895, p. 255.

high degree of histological differentiation. The sexual generation of plants is at the best a miserable failure from the morphological point of view, and this must be set down to the factors already indicated.

The higher one ascends the smaller it becomes, until, in the highest flowering plants, it has almost reached the vanishing point, without, however, being able to disappear entirely.

In animals it is the larva, the phorozoon, or asexual generation, which makes the bravest show in the lower Metazoa; but even here it is always overshadowed in degree of morphological differentiation by the embryo or sexual generation. In the higher forms it becomes reduced; but, like the rudimentary sexual generation of the higher plants, it cannot vanish, for it also has its assigned task in the reproductive round.

The sexual generation, or gametozoon, thanks to the importance of the precious cargo of germ-cells which it carries, has received the kindly attentions of Nature, with consequent higher and higher evolution. From a variety of causes, the larva or phorozoon, on the other hand, tends to simplification the higher one ascends. At the best, its organisation is simple, but even this simplicity leans to meagreness in the Vertebrata as they now exist.

With the formation of the primary germ-cells the next item in the life-cycle is the production of an embryo or sexual generation by the self-sacrifice of one for the good of the rest. This is indicated in the diagram as having fallen to the lot of the thirty-seventh germ-cell from the bottom.

In the skate the embryo at first contains no germ-cells, and the primary germ-cells enter it as such; but—and this is another of the facts established by my work—by the time the embryo is completely laid down, the primary germ-cells divide and form secondary ones; so that, as a rule, by the time the evolution of the embryo is over and the critical period is reached, the embryo contains only secondary germ-cells, incapable of independent development.

It may be of interest to record the further fact that in the skate this formation of secondary germ-cells precedes the announcement of the sex of the embryo, and is possibly causally related to it. As we have already seen, the

future sex is betrayed by the nature of the egg itself. It is announced by differentiation of ovary or testis.

So far as the germ-cells themselves are concerned, the duplication of the paternal and maternal nuclear portions is one of no long duration; for a commencement of the undoing of it is made at the formation of the secondary germ-cells. That is to say, the doubling brought about by the conjugation only persists until the primary germ-cells cease to be such, and divide to form secondary ones. Moreover, the tendency of research goes to demonstrate a certain looseness in this union. As Rueckert and Haecker independently showed a few years ago, the paternal and maternal chromosomes remain distinct during the cleavage of *Cyclops*, indeed, in such a manner as to suggest a duplex-nucleus in each of the cells along the germinal track (in Weismann's sense).[1] The like observation was subsequently made by the former in the cleavage-cells of Torpedo, without, however, suggesting any connection with germ-cells. The same duplication was recently noted by the writer in cleavage-cells of *Raja*, as well as in the primary germ-cells here, and the two were brought into connection. The interesting point about the matter appears to the writer to be that, if the reduction of chromosomes at the determination of sex for the following generation be ever a mere undoing of the previous lax union, the resulting germ-cells may reproduce or mimic more or less exactly, if not, indeed, absolutely so, the corresponding germ-cells of a grandparent. After such a reduction and new conjugation the reduced halves of the nuclei have, of course, lost the previous loose union referred to above, in order to acquire a new one of the like nature. Therefore they cannot so easily revert to a great-grand-

[1] The word "epigenesis" is here deliberately avoided. After very prolonged study of the mode of vertebrate development, my conclusion is, that epigenesis has no existence. In the preface to his "Germ-plasm," Weismann writes: "I finally became convinced that an epigenetic development is an impossibility. Moreover, I found an actual proof of the reality of evolution," etc. Though there be no preformation, there is a predestination; and this is finally brought to pass by an evolution or unfolding. In my own work the facts of the development of the thymus, of the lateral sense organs, of the whole gut, etc., are only explicable and intelligible on this view. Evidence of the like kind is also afforded by the facts as to the developmental origin of like-twins. The very instance, chosen by Caspar Friedrich Wolff, that of the development of the alimentary canal, in reality demonstrates in the clearest fashion that its history is one of an evolution. The detailed facts concerning this may be brought forward on an early occasion.

parent. It is, I take it, the looseness of this union of chromosomes, and the ease with which it may be undone at the reduction and sex-determination, which explains why a child, for example, often bears more likeness to a grandparent than to a parent.

As to the rest of the diagram, this relates to the determination of sex, and to the final phases of oögenesis and spermatogenesis. With the exception of the portions relating to the determination of sex, the data concerning oögenesis are taken, as will be recognised, from Boveri's well-known figures. Of course, the embryo is not supposed to be hermaphrodite; both sexes being included in one diagram merely for purposes of convenience.

For fuller details concerning the determination of sex, the reader may be referred to my recent communication[1] on this subject. In the upper part of the diagram, attached to the fifty-fifth primary germ-cell, the probable course of oögenesis in the skate is shown. With the final division of the oögonium into two oöcytes, o.c., the determination of sex is depicted as happening in the formation of male oöcytes and female ones. These enter the period of growth, and then pass on to ripen. Lower down, for comparison, the spermatogenesis of *Paludina*, with its two kinds of spermatozoa, is represented after the statements of Meves.

The portions of the diagram appended to the fifty-fifth and twentieth primary germ-cells can naturally be applied to any of the remaining primary germ-cells, other than that which goes to form the embryo.

In conclusion, what Weismann has termed the germinal track nowhere here touches the cells of the embryo. Neither, as we have seen, does it really lie within the asexual generation, or phorozoon. It is along a line of unicellular organisms, which pass a portion of their life-cycle between one conjugation and the succeeding one within a sterilised individual, formed by the self-sacrifice of one for the good of the rest.

As revealed by the diagram, throughout this line of unicellular organisms, which are ever such, until one or other of them gets into the *cul-de-sac* of embryo-formation, there is a direct morphological continuity of germ-cells.

[1] See "Anat., Aug. 1902," and for the full memoir, "Zool. Jahrb., Morph. Abtheil, 1902."

This is all Nature demands; and this she accomplishes by the aid of unicellular organisms. All the observed phenomena of development, all those of heredity, are possible in this way.[1] Notwithstanding apparent complexity, the process is simplicity itself, the simplest kind of continuity conceivable.

On the circle of life revolves the epicycle of the germ-cells. The circumference of the former is filled in by an uninterrupted succession of such epicycles. The constant sequence of these is the rhythm of reproduction, the gamut of life.

## EXPLANATION OF FIGURES.

Fig. 1. Diagram of the Life-Cycle of the Skate (*Raja batis*), illustrating the union of egg and sperm, E. and S., to form the zygote, Z., the origin of the phorozoon, or larva, or asexual generation, the germinal track from Z. to U.K.Z., which is the primitive germ-cell. The division of the primitive germ-cell is carried to six mitoses, giving 64 primary germ-cells, P.G.C., instead of the full number of 9 divisions in a female skate, yielding 512 primary germ-cells Diagrammatically the evolution of one primary germ-cell, the 37th, is depicted as forming the embryo or gametozoon. To complete the track of heredity from generation to generation through the morphological continuity of the germ-cells—to the 55th primary germ-cell a diagram of oögenesis, with the formation of male and of female-eggs, and of spermatogenesis (as in *Paludina* after Meves' work) to the 20th germ-cell, have been added. In the latter the formation of the ordinary spermatozoa, H.S., and of the non-functional worm-like ones, W.S., are shown. *N.B.*—In the diagram of oögenesis the "ripening" of a female-egg is indicated by the larger, and that of a male-egg by the smaller, oöcyte and products.

Fig. 2. A portion of E. B. Wilson's diagram of the egg-cleavage of *Nereis*.

Fig. 3. The egg-cleavage of *Nereis*, depicted in Fig. 2, represented after the fashion of Fig. 1.

[1] Were proof wanting of the application of the results of the present research even to the highest animals, it might be found in Hubrecht's remarkable researches into the early development of *Tupaja javanica*. (A. A. W. Hubrecht, "Die Phylogenese des Amnions und die Bedeutung des Trophoblastes," Amsterdam, 1895.) Here the first products of the egg-cleavage are a small number of cells, forming a sac, the trophoblast, and containing one central cell, out of which the entire embryo arises.

As is now well known, Hubrecht homologises the trophoblast with the larval skin of an Amphibian. It is by no means a new idea to the writer that the trophoblast represents the whole or the greater part of the asexual generation in mammals. The single clear cell in the sac in *Tupaja* must either be the primitive germ-cell, which must give rise not only to the embryo, but also to the sexual products, or it must become the primitive germ-cell after one or two additional mitoses. It may be regarded as eloquent testimony of the correctness of my conclusions, that in *Tupaja* Hubrecht should have found the very things which might have been postulated.

## EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO COUNTY KERRY IN 1901. By Rev. DAVID PAUL, LL.D.

(Read 9th January 1902.)

During the thirty-one years of its existence, the Scottish Alpine Botanical Club has met five times outside the bounds of Scotland. In 1884 it met in Teesdale, in 1887 in Norway, in 1890 in Connemara, in 1899 at Kirkby-Lonsdale, and last year in County Kerry. It is of this last meeting that the following report is now presented to the Botanical Society.

The members who took part in the expedition were—Mr. W. B. Boyd, the President; Dr. Paul, the Secretary and Treasurer; Messrs. Arthur H. Evans, M.A.; George Potts; Alex. Somerville, B.Sc.; Robert Turnbull, B.Sc.; and F. C. Crawford; with Mr. Alex. Cowan as a visitor. The majority of these left Greenock on the evening of 29th July, and arrived in Dublin next morning. As the train for Killarney did not leave till the afternoon, there was time to pay a visit to the Botanical Garden at Glassnevin, and a considerable time was spent there in examining its many interesting plants. Among these may be specially mentioned—*Gerbera Jamesoni*, *Amaryllis Ackermanni*, *Fulegia paradoxa*, *Daphne Blagyana*, *Crinum Powelli* (both white and red varieties in fine flower), *Romneya Coulteri* (very fine), *Zauchneria californica*, *Calceolaria alba*, and *Digitalis orientalis*. In the hothouses were some beautiful specimens of Lotus and Nymphæas, and a very fine plant of the *Victoria regia* lily, rivalling those that are to be seen growing in British Guiana. It would have taken a much longer time than we could spare to give attention to one half of the interesting plants that we were obliged hurriedly to pass by.

We left Dublin at four o'clock, and reaching Killarney at eight we put up at the Lake Hotel. There we were joined by Dr. Reginald W. Scully, F.L.S., who very kindly put his intimate knowledge of Irish botany at our service, and whose courtesy and valuable assistance we cannot sufficiently acknowledge.

Wednesday, the 31st July, was spent at Killarney. Six

of the party made the well-known excursion, by carriage and boat, through the Gap of Dunloe, returning by the Lakes. I am indebted to Mr. Turnbull for the following notes: "On approaching the Gap, we saw several pasture-fields with the striking yellow flowers of *Bartsia viscosa*, in much the same profusion as we see the Yellow Rattle at home. Farther up, but before we reached the Gap, we observed wet patches of colour near the road, and these consisted chiefly of *Hypericum elodes*, with an edging of *Anagallis tenella*, forming a lovely and perfect combination of arrangement and colour impossible to reproduce in a garden. All the way up the Gap, almost every crevice of rock had its nest of *Saxafraga Geum* and *S. umbrosa*, with several varieties and apparently intermediate forms. *S. umbrosa* has been incorrectly called 'St. Patrick's Cabbage.' Mr. Colgan, who has paid much attention to the Celtic names of plants, is of opinion that the more correct name would be 'Fox's Cabbage,' and that the mistake has arisen from the similarity of the Celtic words for 'fox' and 'St. Patrick.' On the stone walls in the Gap, *Sedum album* was common, and the foliage of *Pinguicula grandiflora* was conspicuous everywhere. The place of the common Gorse was occupied by dwarf clumps of *Ulex Gallii*, with its pale yellow flowers. On the moor beyond the Gap we observed all three species of *Drosera* in great profusion, and near the same place were clumps of *Cladium jamaicense*. As we neared the upper lake, we found much *Euphorbia hiberna* by the roadside. Salmon poachers express the latex from this plant, and stupify the fish by putting it into the streams. In Donegal this Spurge attains its extreme northern limit for Europe. In Britain it has been found only in North Devon. The Royal fern occurs in great profusion in the neighbourhood of the Lakes."

While this party were making their round by the Gap of Dunloe, Mr. Evans and Dr. Paul, accompanied and guided by Dr. Scully, spent the forenoon on the lower lake. Rowing first to the mouth of the Flesk River, we found—*Alisma ranunculoides*, L., in very fine form; the lovely *Wahlenbergia hederacea*, Reichb.; *Microcala filiformis*, Hoffm. and Link., found only in the extreme south-west of Ireland; *Bartsia*

*viscosa*, L.; *Potamogeton pusillus*, L.; *Eleocharis acicularis*, R. Br. Proceeding next to Ross Bay and the grounds of Muckross Abbey, we found—*Equisetum variegatum*, var. *Wilsoni*, Newm.; *Callitriche autumnalis*, L.; *Galium sylvestre*, Poll.; *Lastræa Thelypteris*, Presl.; *Nitella Nordstedtiana*, Groves; *N. translucens*, Agardh.; *Naias flexilis*, Rostk.; *Chara flexilis*, Desv.; *Potamogeton lucens*, L.; and *P. perfoliatus*, L.

In addition to these plants, there were found next day, chiefly in the Muckross Abbey Grounds, by the party who had made the Dunloe excursion, the following:—*Rubia peregrina*, L.; *Galium boreale*, L. (near Lake Hotel); *Pimpinella major*, Huds. (common); *Geranium lucidum*, L.; *Hypericum calycinum*, L. (in masses); *H. Androsæmum*, L. (occasionally); *Agrimonia Eupatoria*, L.; *Petasites fragrans*, Presl.; *Saponaria officinalis*, L.; *Arbutus Unedo*, L.; *Veronica Tournefortii*, C. Gmel.; *Calamintha officinalis*, Mœnch.; *Carex paniculata*, L.; *C. remota*, L.; *C. Bœnninghausiana*, Weihe; and *Ophioglossum vulgatum*, L.

On Thursday, 1st August, the majority of the members of the party with Dr. Scully went on by rail to Kenmare, and put up at the Southern Hotel. At Headford Junction, *Senecio vulgaris*, var. *radiatus*, Koch., was abundant. Strolling in the neighbourhood of the town in the afternoon, they picked up *Pinguicula grandiflora*, Lam. (larger than in the Gap of Dunloe); *Verbena officinalis*, L.; *Hypericum humifusum*, L.; *Carex divulsa*, Good.; *Asplenium adiantum-nigrum*, L.; *A. trichomanes*, L.; *A. Ruta muraria*, L.; *Lastræa æmula*, Brack.; *Ceterach officinarum*, Willd.; *Scolopendrium vulgare*, Sym. On the seashore—*Statice rariflora*, Drej.; *Suæda maritima*, Dum.; *Salicornia herbacea*, L.; *Aster Tripolium*, L.; and *Rumex crispus*, var. *littoreus*, Hardy.

On the following day the same party drove to the Cloonee Lakes, on the south side of the Kenmare River, and seven miles distant from the town. On this expedition they had the advantage of the assistance of Mr. Nathaniel Colgan, M.R.I.A., who had come to Kenmare to meet them. He and Dr. Scully are the joint-editors of the valuable "Cybele Hibernica." Several interesting plants were found, notably, *Eriocaulon septangulare*, With.; *Sisyrinchium angustifolium*, Mill; *Microcala filiformis*, Hoffm. and Link.;

*Rynchospora fusca*, Rœm. and Schult.; and *Carex punctata*, Gaud.

The *Eriocaulon* is not uncommon in the west of Ireland, growing usually near the sea. It is plentiful in Connemara. In Britain it occurs only in Skye and Coll, and in one or two of the neighbouring islands. It is a North American species, and is not found on the continent of Europe. Here it was growing in extensive patches, submerged in the water, and also on the soaking, muddy soil at its edge. The *Sisyrinchium* grew among the stones above the shore-line. Its small blue flowers had a charming effect, and only a limited number of specimens were gathered. It is confined to Kerry, Cork, and Galway. It is a North American plant, and there is reason to believe that it is not truly indigenous in Ireland. *Microcala filiformis* was found only after a long search. It is a minute, slender, fairy-like plant, of an erect habit, only an inch or two high, topped by a rich yellow flower like a miniature gentian. It was seen first in wet ground near the sea, and again in ditches near the lakes. *Carex punctata* was growing almost on the seashore. It occurs only in Kerry and Cork, but is locally abundant.

Other plants found on this expedition were—*Carex extensa*, Good.; *Scirpus Tabernæmontani*, Gmel.; *S. maritimus*, L.; *Juncus maritimus*, Lam.; *Pinguicula lusitanica*, L.; *Lobelia Dortmanna*, L.; *Drosera intermedia*, Hayne; *Elatine hexandra*, DC.; *Mentha Pulegium*, L.; *Juncus tenuis*, Willd.; *Anthemis nobilis*, L.; *Bartsia viscosa*, L.; *Scutellaria minor*, Huds.; *Hypericum elodes*, L.; *Utricularia minor*, L. (in flower); and *Lastræa æmula*, Brack.

The two members of the Club, Mr. Evans and Dr. Paul, who had not come on at once to Kenmare, left Killarney on 31st July and travelled by rail *viâ* Tralee and Castle-Gregory to Cloghane. The train to Tralee arrived too late to catch the last train of the primitive light railway to Castle-Gregory, and this misfortune made it necessary to drive first to Castle-Gregory and then on to Cloghane—a distance altogether of about twenty miles. The evening, however, was fine, and the drive along the seacoast was much enjoyed. Arriving at their destination they found quarters at Mrs. O'Connor's inn, situated in the little

village, and of very humble appearance, but clean and comfortable. Here they remained from the Wednesday evening till the Saturday morning, and they can recommend Mrs. O'Connor's to any botanist who may desire accommodation in that part of Kerry.

The main object in view was to find the Killarney fern. Unfortunately, the first day, Thursday, was very wet, and the search was unsuccessful,—the searchers being compelled to return to the inn early in the afternoon, drenched. The next day, however, was fine, and, having with them as guide a very intelligent man belonging to the village, who professed to know where the plant was growing, they again passed up the valley of the Owenmore, a fine fishing stream, to the point where the road is crossed by a tributary burn issuing from Lough Cruttia. This tributary they followed up till they reached the Lough, a sheet of water about a mile long by a quarter of a mile broad. The guide led them up the rocky hillside on the south-west side of the Lough, to a point about 300 feet above its level, and showed them a pretty large plant of the fern growing in a deep hole among the boulders. There was no water near, and it seemed to be entirely dependent on the rain for the moisture it requires. One or two leaves were taken, but the plant was left undisturbed. Another similar hole, under a great rock farther up the hillside, was pointed out, where a much larger plant was recently growing, but the whole of it had been rooted up and sold. The guide, who knew the fern well, said he had very carefully searched over the whole hillside, and looked into every likely hole, but that he knew of no other plant now remaining. It was satisfactory to see even a single plant of it, although one had to be led to the spot by a guide.

*Trichomanes radicans*, Swartz, is found, or used to be found, in seven of the twelve botanical districts into which Ireland is divided; but in many of its former localities it has been exterminated. It was formerly plentiful in parts of Kerry, whereas it is now very rare in the country. In 1858 it was "abundant on the Torc Mountain" near Killarney, and it was seen there as late as 1889; but Dr. Scully states in the "Cybele Hibernica"

that it is "nearly, if not quite, exterminated in the districts of Killarney and the Reeks." Unfortunately it acquired a money value, and, wherever it could be obtained, the people of the locality earned a few shillings by selling it to tourists, not one in twenty of whom would be able to grow it when they had it. It is sad to think that so interesting a plant should be doomed to extinction to satisfy an ignorant and stupid cupidity. There was a dying specimen in the inn at Cloghane, which had evidently been quite recently gathered in the neighbourhood, and which a poor attempt was made to grow under impossible conditions. No plant of *Trichomanes*, except that seen at Lough Cruttia, was observed by any member of the Club during the expedition, but doubtless a good many isolated plants still occur, scattered here and there over the vast mountainous region of Kerry. The guide indicated one other spot, at some distance from the Lough, where he said it was to be found.

The only other plant particularly noteworthy found in the neighbourhood of Cloghane, was the rare *Sibthorpia europæa*, L., which was observed growing on the roadside near Kilcummin, on a bare, moist, almost vertical bank. In Ireland this plant is confined to the Dingle peninsula.

Other plants seen by Messrs. Evans and Paul, and not already mentioned as occurring at Killarney or Kenmore, were *Althæa officinalis*, L. (probably a garden escape); *Samolus Valerandi*, L.; *Pulicaria dysenterica*, Gærtn.; and *Viola tricolor*, var. *Curtisii*, Forst.

Making an early start on Saturday morning, these two members of the Club journeyed back by Tralee and Killarney to rejoin the others at Kenmare, which they reached at midday, only regretting that their stay amid the romantic scenery of Cloghane had been so brief.

The same day the whole party drove in the afternoon from Kenmare to Parknasilla, near Sneem, along a road which presented at every turn fine views of the mountains and of the picturesque estuary. The commonest plants by the wayside were *Ulex Gallii*, Planch, and *Anthemis nobilis*, L., the latter in great profusion. As we drove along, Messrs. Cowan and Boyd were each fortunate enough to find an interesting variety of the Royal fern, amid the

myriads of magnificent specimens growing in the water-ditches. Mr. Druery, to whom they have been submitted, proposes to call the variety found by Mr. Cowan, *decomposita*, and that found by Mr. Boyd, *plumosa*. At Parknasilla we found the Southern Hotel spacious and comfortable, and there we remained until the party broke up.

4th August.—Several members of the party, along with Dr. Scully and Mr. Colgan, drove through Sneem to a point about half-way to Derrynane, and then turned sharp to the right up the hill for a few miles, in quest of two very rare plants, *Polygonum sagittifolium*, L., and *Simethis bicolor*, Kunth, both of which were found. The *Polygonum* was discovered by Dr. Scully in 1889, growing abundantly in one or two localities in the neighbourhood of Castle-Cove, and it has not been found elsewhere in Great Britain or Ireland. It is "common in low grounds in the Northern United States." "It seems best to regard it as an alien introduced by some accidental means, and now fully established in a wild locality" ("Cyb. Hib.") The *Simethis* was found in crevices of the rocks near the road. Its headquarters are in the immediate neighbourhood of Derrynane, but it also occurs for eight or nine miles east of that place, here and there by the shore of Kenmare River. Except for the one English station of Bournemouth, it is confined to this limited locality in the south-west of Kerry, so that it may be regarded as one of our rarest plants. *Salix pentandra*, L., was also observed on this excursion, an uncommon tree in Ireland, and probably not indigenous in the south. The other plants noticed have already been mentioned as belonging to the district.

In the neighbourhood of the Parknasilla Hotel fine plants of *Crithmum maritimum*, L., were found growing on the rocks by the side of the estuary, and, in great luxuriance, on the gravel. *Lastræa æmula*, Brack., was a common fern in the extensive and beautiful grounds of the hotel, and specimens of *Carex extensa*, Good., with very long bracts were gathered.

Next day, 5th August, the members of the Club separated, and the meeting came to an end, to the great regret of all, for the beauty of the scenery and the occurrence of so many unfamiliar plants had rendered

it peculiarly interesting and enjoyable. We were greatly favoured by the presence and assistance of Dr. Scully and Mr. Colgan, both adepts in the botany of Ireland, to whom our grateful thanks are due. Most of the party travelled back by Kenmare and Killarney direct to Dublin and Glasgow. Two subsidiary excursions were, however, carried out, one by Mr. Somerville, and the other by Messrs. Evans, Crawford, and Paul.

Mr. Somerville proceeded alone to Valencia Island, taking the beautiful coach drive by Sneem, Waterville, and Cahirciveen, crossing from the latter place to the island, which is largely grass moorland. *Euphorbia hiberna*, L., was plentiful on the eastern side; *Lastræa æmula*, Brack., frequent on the western side; while *Bartsia viscosa*, L., was observed on wet ground. The wooded northern end would probably reward botanical search. Growing in Knight's Town with *Sagina maritima*, var. *debilis*, Jord., was *Spergularia rubra*, Presl., unrecorded for County Kerry in Præger's "Top. Bot. of Ireland." Mr. Somerville returned by rail to Killarney.

Messrs. Evans, Crawford, and Paul paid a flying visit from Dublin to Connemara in search of the heath *Erica Stuarti*, which Dr. Charles Stuart, of Chirnside, found there in 1890. Travelling by rail to Ballinahinch, which is the nearest station to the low hill on which the heath was found, they were unable, after careful examination, to discover it again, although there is every likelihood that it is still growing there. *Erica Mackayii*, Hook., was growing in abundance and in great beauty, and Mr. Crawford was fortunate enough to find in some quantity the particularly fine very double variety of it, which was exhibited to the Society at its last meeting, and which is again upon the table to-night. Nothing else of any special note was observed.

Here follows a combined list of the more remarkable plants gathered during the whole excursion:—

Nymphæa lutea, L.—Killarney.
Castalia speciosa, Salisb.—Killarney.
Viola Curtisii, Forster—Cloghane.
Saponaria officinalis, L.—Muckross Abbey.
Arenaria trinervia, L.—Muckross Abbey.
Spergularia rubra, Presl.—Valencia.

Elatine hexandra, DC.—Kenmare.
Hypericum Androsæmum, L.—Muckross Abbey.
—— calycinum, L.—Muckross Abbey.
—— humifusum, L.—Kenmare.
—— elodes, L.—Gap of Dunloe, etc.
Althæa officinalis, L.—Cloghane.
Geranium lucidum, L —Muckross Abbey.
Euonymus europæus, L.—Killarney.
Ulex Gallii, Planch—Kenmare, etc.
Agrimonia Eupatoria, L.—Muckross Abbey.
Saxifraga Geum, L.—Killarney, etc.
—— umbrosa, L.—Killarney, etc.
—— tridactylites, L.—Killarney.
Cotyledon umbilicus, L.—Killarney.
Sedum album, L.—Gap of Dunloe.
Drosera rotundifolia, L.—Killarney, etc.
—— anglica, Huds.—Killarney, etc.
—— intermedia, Hayne—Killarney, etc.
Callitriche autumnalis, L —Killarney.
Circæa lutetiana, L.—Killarney, etc.
Pimpinella major, Huds.—Muckross Abbey.
Rubia peregrina, L.—Muckross Abbey.
Galium boreale, L.—Killarney.
—— sylvestre, Poll.—Killarney.
Aster Tripolium, L.—Kenmare.
Pulicaria dysenterica, Gærtn.—Cloghane.
Anthemis nobilis, L.—Kenmare, etc.
Petasites fragrans, Presl.—Muckross Abbey.
Senecio vulgaris, *var.* radiatus, Koch.—Headford Junction.
Erica Mackayii, Hook., and double variety—Connemara.
Lobelia Dortmanna, L., Kenmare.
Jasione montana, L.—Killarney, etc.
Wahlenbergia hederacea, Reichb.—Killarney.
Arbutus Unedo, L.—Killarney.
Statice rariflora, Drej.—Kenmare.
Lysimachia nemorum, L.—Killarney.
Anagallis tenella, L.—Killarney, etc.
Samolus Valerandi, L.—Cloghane.
Microcala filiformis, Hoffm. and Link.—Kenmare.
Erythræa centaurium, Pers.—Kenmare.
Sibthorpia europæa, L.—Cloghane.
Veronica Tournefortii, C. Gmel.—Muckross Abbey.
Bartsia viscosa, L.—Killarney, etc.
Orobanche Hederæ, Duby.—Killarney and Muckross.
Utricularia minor, L.—Kenmare.
Pinguicula grandiflora, Lam.—Killarney, and near Sneem.
—— lusitanica, L.—Kenmare.
Verbena officinalis, L.—Kenmare.
Mentha Pulegium, L.—Kenmare.

Calamintha officinalis, Mœnch.—Muckross.
Scutellaria minor, Huds.—Gap of Dunloe.
Salicornia herbacea, L.—Kenmare.
Suæda maritima, Dum.—Kenmare.
Polygonum sagittifolium, L.—Derrynane.
Rumex crispus, *var.* littoreus, Hardy—Kenmare.
Euphorbia hiberna, L.—Killarney, etc.
Salix pentandra, L.—Sneem.
Sisyrinchium angustifolium, Mill—Kenmare.
Simethis bicolor, Kunth—Derrynane.
Juncus tenuis, Willd.—Kenmare.
—— maritimus, Lam.—Kenmare, etc.
Alisma ranunculoides, L.—Killarney.
Potamogeton lucens, L.—Killarney.
—— perfoliatus, L.—Killarney.
—— pusillus, L.—Killarney.
Naias flexilis, Rosk. and Schmidt—Killarney.
Eriocaulon septangulare, With.—Kenmare.
Eleocharis acicularis, R. Br.—Killarney.
Scirpus Tabernæmontani, Gmel.—Kenmare.
—— maritimus, L.—Kenmare.
Rynchospora fusca, Rœm. and Schult.—Kenmare.
Cladium jamaicense, Crantz—Killarney.
Carex paniculata, L.—Muckross,
—— divulsa, Good.—Kenmare.
—— remota, L.—Muckross.
—— Bœnninghausiana, Weihe—Muckross.
—— extensa, Good.—Kenmare.
—— punctata, Gaud.—Kenmare.
Trichomanes radicans, Sw.—Cloghane.
Lastræa Thelypteris, Presl.—Muckross.
—— æmula, Brack.—Parknasilla, etc.
Ophioglossum vulgatum, L.—Killarney.
Hymenophyllum tunbridgense, Sm.—Killarney.
—— unilaterale, Bory—Killarney.
Polypodium vulgare, *var.* semilacerum.—Killarney.
Osmunda regalis, L.—Killarney, etc.
Ceterach officinarum, Willd.—Kenmare.
Equisetum variegatum, *var.* Wilsoni, Newm.—Killarney.
Chara flexilis, Rosk. and Schmidt—Killarney.
Nitella Nordstedtiana, H. and J. Groves—Killarney.
—— translucens, Agardh—Killarney.

## THE BOTANICAL RARITIES OF A SUB-ALPINE PARISH.

By JAMES M'ANDREW, Assoc. of Edin. Bot. Soc.

(Read 13th February 1902.)

The parish I refer to is that of Kells, situated about the middle of Kirkcudbrightshire, and formed by a hilly ridge—a spur of the Lowther and Lead Hills, running in a southerly direction—and two slopes, one to the west to the Blackwater of Dee, and the other to the east to the river Ken, these slopes being intersected by several shaded sub-alpine glens or, rather, ravines. Loch Ken forms part of the eastern boundary of Kells. With the exception of some arable land along the river Ken and Loch Ken, all the parish consists of moors and hills suitable only for sheep farms. The highest hill is Corserine, 2650 feet high. The salubrity and moistness of the climate, and the diversified surface of hills, bogs, dales, glens, burns, rivers, lochs, and woods, render this inland parish peculiarly favourable for the growth of cryptogamic plants, which here flourish in unusual profusion and variety, notwithstanding the fact that the two rock formations of the whole parish are granite and greywacké—rocks which, in general, are not very productive of plant life. The trunks of the trees, too, are luxuriantly covered with cryptogamic vegetation.

I may here say that I have published in the "Transactions of the Dumfries and Galloway Natural History, etc., Society" lists of the Flowering Plants, Ferns, Mosses, Hepaticæ, and Lichens of the south-west of Scotland, from which I would cull the following from the Parish of Kells, showing that there is truth in the remark that that district is the richest in plants, which has been most carefully searched, and that too by one resident in the district.

FLOWERING PLANTS.—On the hills and moors are such plants as—*Thalictrum alpinum*, L.; *Salix herbacea*, L.; *Lycopodium alpinum*, L.; *Sedum roseum*, Scop.; *Carlina vulgaris*, L.; *Carduus heterophyllus*, Willd.; *Hieracium holosericeum*, Backh.; three species of *Drosera*; *Pinguicula lusitanica*, L.; and *Listera cordata*, R. Br., among heather on the hillsides. Lower down are *Ranunculus Lenormandi*,

F. Schultz.; *Radiola linoides,* Roth.; *Lathræa squamaria,* L.; *Melica nutans,* L.; and *Millium effusum,* L., in the woods; *Avena pubescens,* Huds., and *A. pratensis,* L., on hilly pastures; *Serratula tinctoria,* L., by the side of Loch Ken. *Hymenophyllum unilaterale,* Bory; *Polystichum angulare,* Presl.; *P. lobatum,* Presl.; and *P. aculeatum,* Syme; with abundance of oak and beech ferns, flourish in the sub-alpine glens. The carices and the grasses are also well represented. Among the former is *Carex aquatilis,* var. *elatior,* Bab., with its form *virescens,* Anders., in great plenty. What I consider the three rarest plants of the parish are—*Juncus tenuis,* Willd., gathered in two stations by myself in 1887, and since then in other two stations in Kirkcudbrightshire; *Carex elongata,* L., in 1887, in a lagoon in Kenmure Holms, and here also I found *Calamagrostis lanceolata,* Roth., in 1884, a grass which, as far as I am aware, has not been gathered elsewhere in Scotland.

MOSSES.—In bogs, and on wet hill slopes, etc., are found a great majority of the Sphagna of the British Islands. Among these are *Sphagnum Austini,* Sull., with var. *imbricatum,* Ldb.; *S. medium,* Limpr.; *S. tenellum,* Ehrh.; *S. rigidum,* Schp.; *S. Mülleri,* Braith.; *S. papillosum,* Ldb.; *S. Girgensohnii,* Russ.; *S. teres,* Ångstr.; and many vars. and forms of *S. acutifolium,* Ehrh. On the wet moors the *Campylopi* are very fine. On the higher hills are to be gathered—*Rhabdoweissia crenulatus,* Jameson; *Dicranum Schisti,* Ldb.; the *Grimmias, decipiens,* Ldb., *incurva,* Schultz., *torquata,* Hornsch., *funalis,* Schp., *commutata,* Hüb., and *patens,* B. and S.; *Œdipodium Griffithianum,* Schwg.; *Ulota Hutchinsiæ,* Hamm.; the *Grimmias, Hartmanni,* Schp., and *subsquarrosa,* Wils., by the side of Loch Ken; *Grimmia Doniana,* Sm., on dry whinstone dykes. *Grimmia Stirtoni,* Schp.; *Hedwigia ciliata,* var. *striata,* Wils.; and *Myrinia pulvinata,* Schp., also occur. The rarer *Hypnums, callichroum,* Brid., *intermedium,* Ldb., *aduncum,* Hedw., *eugyrium,* var. *Mackayii,* Schp., *brevirostre,* B. and S., *depressum,* Dixon, etc., are all found. I also once gathered *Buxbaumia aphylla,* L., in the parish.

HEPATICÆ.—The sub-alpine glens in Kells Parish are particularly suitable to the growth of Hepaticæ, of which many species are found. Some of the rarest are—*Porella*

*rivularis*, Nees; several of the *Lejeuneæ*; *Radula aquilegia*, Tayl.; and *R. Lindenbergii*, Gottsche; *Lepidozia Pearsoni*, Spr.; *Jungermannia Pearsoni*, Spr.; *Scapania subalpina*, Nees; *Hygrobiella laxifolia*, Hook.; *Aplozia autumnalis*, DC.; *Metzgeria hamata*, Ldb.; *Aneura palmata*, Hedw.; and *Riccia glaucescens*, Carr. The rarest hepatic I gathered in the parish was *Harpanthus Flotovianus*, Nees, but only a few stems of it. This hepatic has only been found in two or three places in the kingdom.

LICHENS.—The lichens are also in great plenty, especially the Cladoniæ, of which there are about thirty species, besides varieties, and among these the rare *Cladonia leptophylla*, Ach. Of Cladoniæ sent by me to Dr. Stirton, he made about sixteen forms of *C. subsquamosa*, Nyl. These are given in the "Scottish Naturalist" of 1888, as also several new forms of *Usnea*. Other genera of lichens are equally well represented. I may mention *Platysma commixtum*, Nyl.; *Sticta intricata*, var. *Thouarsii*; *Umbilicaria pustulata*, Hoffm., which occurs in great plenty across the river Ken in the neighbouring parish; fourteen species of *Parmelia*, as *P. pertusa*, Schrank, *P. Borreri*, Turn., *P. incurva*, Pers., etc.; and *Leptogium Burgessii*, Lightf. On sloping granite rocks on Cairnsmuir of Dee is found in two stations the very rare lichen *Synalissa intricata*, Nyl., which, as far as I am aware, has not been found elsewhere in Britain. The same hill has also *Pilophoron fibula*, Tuck. Dr. Stirton has in the "Scottish Naturalist" named and described two new lichens from this parish. *Parmelia reddenda*, Strn., growing on ash trees. Some lichenologists maintain that this *Parmelia* is only a form of *P. Borreri*, Turn. I have found it sparingly in other places. The other lichen is *Lithographa Andrewii*, Strn., growing parasitically on *Lecanora tartarea*, L. Dr. Nylander, of Paris, has also named three new species from the parish, viz. *Lecidea umbralis*, Nyl., a form of *L. Lightfootii*, Sm., growing on alder trees; *L. neglectella*, Nyl., and *Pannularia perfurfurea*, Nyl.

FUNGI.—I know very few fungi, but the rarest find I made among this class of plants was in 1878 of *Sphæria riccioidea*, Bolt., or *Hypocrea riccioidea*, Berk. In the "Scottish Naturalist" of 1878, p. 304, is an interesting

note by the Rev. Dr. Stevenson, of Glamis, on this fungus. It is there mentioned that this remarkably rare fungus was only twice found on the Continent, and not in England since February 1790. I may say that I found this fungus in two stations in Kells Parish, and twice in the neighbouring parishes. It grows on dead willows. I have seen no record of any other one finding it.

Functional Inertia—A Property of Protoplasm. By David Fraser Harris, B.Sc. (Lond.), M.D., Lecturer on Physiology and Histology in the University of St. Andrews.

(Read 13th February 1902.)

I. Just as "dead" matter has two forms of inertia—that of rest (mass) and that of motion (momentum), so too, I think, has living matter (protoplasm, whether animal or vegetable). It is owing to the inertia of matter at rest that the heavy gate, swung on even almost frictionless hinges, cannot be instantaneously set in motion, and, when it has been set swinging, it is owing to its inertia of motion (momentum) that it continues to swing for some time after we have ceased to push it. Now, I think, protoplasm has a functional inertia—that property of remaining in the *status quo ante* for a longer or shorter time according to the function considered, that property of continuing to act as it has been acting, in spite of the application of a stimulus tending to effect a change of action, and that power of continuing to exhibit the phenomena it has been exhibiting after even the death of the organism of which it is a constituent. The inertia of protoplasm is, then, the capacity for remaining in the functional *status quo ante.* This inertia of "livingness" expresses itself under several different modes or categories —bio-chemically, as "latent period," as "refractory period" (physiological insusceptibility), rhythmically, or as accompanied by a conscious correlate, according as we study the manifestations of the livingness from the standpoints respectively of chemical change, time-relation to stimulus, affectability, alternation of metabolic phase, or finally consciousness. Livingness is, from the bio-chemical stand-

point, bound up with the two-phased process of metabolism in which, while anabolism and katabolism are coexistent and mutually adjusted, it is generally possible, at any given instant, to say, with regard to most tissues, whether anabolism or katabolism is the predominating or characteristic phase. There would, then, be a functional inertia of katabolism (or katabolic inertia), a tendency for that phase pre-eminently to be continued after the reception of a stimulus tending to induce any other metabolic distribution (anabolism either equal to or greater than katabolism), and conversely, there would be a functional inertia of anabolism (or anabolic inertia), the tendency for that phase pre-eminently to be continued in spite of a stimulus of opposite nature. This power of maintaining the *status quo ante* of a particular phase of metabolism, I call the functional inertia of the protoplasm. As examples of katabolic inertia, there is that large class embracing all cases of local life, of organs, tissues or cells, after somatic death, the *post-mortem* expression of the functional inertia of katabolism, *e.g.* the muscle of the familiar "nerve muscle preparation," which still "acts" though removed from its nutrient lymph, the excised and isolated bloodless frog-heart beating on a glass plate for hours after the death of the animal, the isolated medullated nerves still giving evidence of conductivity for many hours after excision, the vivisected, non-nucleated portion of *Lacrymaria olor*,[1] and other *Protista*, the ciliated epithelium from frog's gullet living for days as an isolated patch, and even the isolated cilium itself exhibiting movements "till it perishes." In this class I do *not* include the cases of organs surviving by reason of perfused defibrinated blood, for here their metabolism is being constantly supported by nourishment applied under artificial conditions; but I would include all cases of organs isolated from all nervous and vascular connections, and surviving by reason of the perfusion of salt solution. No food is thereby introduced, the NaCl is powerless to prolong life indefinitely—no longer than the time when the katabolic inertia of the protoplasm shall have been spent. Of course organs and tissues still *in situ* in the dead body can exhibit their

[1] Verworn. "General Physiology." London, 1899, p. 570.

katabolic inertia; examples are numerous, *e.g.* the respiratory centres emitting impulses even after evisceration in Marmot (Marckwald), the *post-mortem* continuation of intestinal peristalsis, the medullated nerves remaining excitable three to four days after severance from the central nervous system, the growth of hairs, and all cases of local cell-life after death—spermatozoa in the vesiculæ seminales, cilia in trachea, etc., and amœboid leucocytes generally. All cases of *post-mortem* bio-chemical change are illustrations of katabolic inertia, *e.g.* the excised liver continuing to convert glycogen to dextrose, the isolated and bloodless muscle producing $CO_2$ in atmosphere of N or H, the tissues continuing to produce heat, to reduce deoxidisable material brought into contact with them, and the *post-mortem* formation of enzymes generally; also all cases of tissues living without food, whether it be total deprivation (starvation) or partial, as in the withdrawal of $O_2$, or $H_2O$, are examples of katabolic inertia. Of course, it is not only in normal conditions that protoplasm exhibits its functional inertia—the very expression of its inertia, when not in harmony with the general well-being of the body, constitutes the "disease."

Thus the Adipose Diathesis is the almost ineradicable and often inherited tendency of certain tissues to deposit fat; but this can be stated as accurately, thus—that fat-deposition is the result of a particular chemical expression of the functional inertia of certain forms of protoplasm, this particular expression of the inertia being "morbid," in that it is abnormally long-continued and altogether excessive. Or, again, we have a pathological chemical manifestation of functional inertia of certain tissues in *Diabetes mellitus.* Their inertia expresses itself chemically in the excessive production of sugar—a tendency in many cases (as also in fat-deposition) not amenable to drugs (chemical stimuli), and morbid, in that it is a disregarding of the metabolic needs of other tissues, for such a quantity of circulating sugar is to them a poison. According to Professor Adami, the property of inertia of protoplasm is one of the essential conditions underlying the perverted "habit of growth" of certain cells which is responsible for many kinds of cancerous tumours. Professor Adami, both

in his paper on "The Causation of Cancerous Growths,"[1] and in a private communication, acknowledges that what he had, since 1896, called "habit of growth" in certain cells, which ought *not* to be proliferating then or there, is "based upon that principle of inertia" concerning which he quotes at some length from my original paper.[2]

I had early seen that it must be in virtue of the inertia of protoplasm that certain cells hold on their disastrous course of local growth, utterly oblivious to the vital needs of adjacent tissues, but I did not feel myself entitled to speak on matters pathological with that authority which belongs to a specialist in pathology. I felt sure the principle was capable of wide application, not only to problems in pathology but in embryology (and teratology), and in the study of inheritance in its widest aspects. Functional inertia seems as universal a property of living matter as is the inertia of non-living matter. In my original paper I used the term functional "momentum" as equivalent to katabolic inertia; I have not persisted in the use of the term, because of the very precise mathematical meaning ($\frac{1}{2}MV^2$) assignable to "momentum"; if, however, momentum be used without this exact signification, and merely as a synonym for "inertia of matter in motion," then there *is* a functional or protoplasmic momentum.

All those cases insisted upon by Heidenhain of organs performing their functions, especially glands secreting, either in the absence of blood or after extreme vasoconstriction, are clearly cases of katabolic inertia; the secretion cannot be indefinitely kept up after the blood-supply (= food-supply) has been cut off, the apparent independence is only temporary, the bloodless protoplasm indeed maintains its secretional *status quo ante*, but only so long as its katabolic inertia persists. Functional inertia expresses itself very markedly in the phenomenon known as "latent period" or "physiological lost time." In the case of stimulation of the cardiac Vagus, it is katabolic inertia that is responsible for the "latency." It is very well known that this stimulus does not take effect at once, but that the time of about a beat and a half (frog's heart) may

[1] "Brit. Med. Journal," 16th March 1901, pp. 624 and 626.

[2] "Brit. Med. Journal," 15th Sept. 1900 (paper read August 1900).

elapse between the instant of the application of the stimulus and the consequent cardiac inhibition. The heart, in other words, gives no "outward and visible sign" of the impending change of condition during, it may be, two beats—the time-expression of the katabolic inertia of cardiac protoplasm. It is shorter but demonstrable in the mammalian heart. Again, it is in virtue of the katabolic inertia of nonstriated muscle that there elapses the relatively very long time (latent period) of 18″ before stimulation of the splanchnic nerve is followed by inhibition of the intestinal movements, *i.e.* induces the anabolic phase. Similarly, the phase of predominating katabolism having been induced, *e.g.* in cardiac acceleration, it will be maintained for 30″ (frog-heart) after the withdrawal of the accelerating stimulus, in virtue of the cardiac katabolic inertia. Thus, as exhibited under the time category, functional inertia is that property of protoplasm in virtue of which it does *not* respond to a stimulus (the time of non-response or latency being longer or shorter according to the tissue and function, in the case of vegetable protoplasm relatively very long—an hour or more), and is thus the opposite property to affectability or irritability. Viewed under the category of non-response itself, functional inertia is the property underlying physiological insusceptibility, "refractory period" and allied states; it is thus the functional counterpart of irritability. It is by reason of the property of irritability that living matter responds to stimuli, but it is in virtue of its other property of functional inertia that it does not do so instantaneously. It is by reason of its affectability that the quiescent heart performs a systole on stimulation; it is by reason of its functional inertia that it performs a maximal systole—the "all or nothing" action, as it has been called, and in virtue of which the heart cannot be tetanised. Just as dead matter cannot be instantaneously caused to change its state, neither can bioplasm; by the inertia of its mass, or of its motion, "dead" matter tends to remain in the *status quo ante*; by the inertia of its livingness (in relative rest or in relative activity) protoplasm tends to remain in its (functional) *status quo ante*.

Passing to cases where there is a conscious correlate, we have, in the positive after-sensation, a good example of

katabolic inertia. An active state has been set up in an end-organ, and has thence been propagated into the central nervous system; a particular sensation is the conscious counterpart. The stimulus is now suddenly withdrawn, but, as is well known, the sensation does not equally suddenly cease—it persists as the + after-sensation due to the katabolic inertia of the tissues involved. This is well-marked in the case of sight, where the + after-image is the correlative in consciousness of the continued activity (post-stimulant) of the retino-cerebral protoplasm, *i.e.* its katabolic inertia. It is to this inertia that the beautiful modern illusions of seeing movement are due, in the instruments known as kinematograph (kinetoscope, mutoscope, etc.).

II. The functional inertia of resting protoplasm, *i.e.* of the characteristically anabolic phase (*anabolic inertia*) is quite as well marked, though there may not be so many familiar examples. We have just spoken of the + after-image; we have a good example of anabolic inertia in the negative after-image. After retinal activity—the katabolic phase—has existed for some time, the phase of relative rest, reconstruction must supervene, and this gives in consciousness the – after-image (reversal of black and white, complementary colours, etc.). Now very often this fades away and is succeeded by the + after-image, that again by the –, there being a series of alternating metabolic phases—the rhythmical or oscillatory expression of the retinal functional inertia, the analogue in living matter of the to and fro swing of the pendulum or the vibrations of the jelly.

Anabolic inertia is well expressed in terms of time-delay, by the familiar "true latent period" of the stimulation of muscle. The muscle is at rest or in its anabolic phase, and the functional inertia of this is exhibited in the no doubt short, but demonstrable, interval between the reception of the stimulus and the commencement of response. In striated muscle it is very short (less than $\frac{1}{100}''$), in nonstriated it is much longer, $\cdot 5''$; in other words, nonstriated muscle has greater anabolic inertia than striated, and this agrees precisely with the conception of functional inertia being the counterpart of irritability, for nonstriated muscle has less irritability than striated.

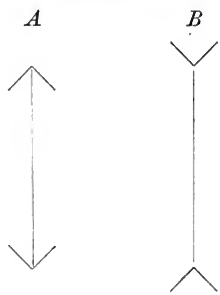
Regarding the inhibition of intestinal muscle through splanchnic stimulation as the establishment of the phase of anabolism, we have anabolic inertia expressed in the persistence of the state of relaxation after the inhibitory stimulus has been withdrawn. This post-stimulant relaxation may last for 25″. Similarly, after the withdrawal of stimuli in cardiac inhibition, there is a (post-stimulant) "latent period" before the heart resumes beating, due to the anabolic inertia of cardiac protoplasm. The latent period that exists before secreto-motor effects in glands appear, is the expression of anabolic inertia in glandular protoplasm: in stimulation of vagal pancreatic secreto-motor fibres, it is as long as 15″ to 3′. Verworn[1] tells us that "the motion of cilia does not begin at the exact moment at which the light strikes them," but only after a "latent period" of one to two seconds—this is anabolic inertia.

More especially expressed under the category of rhythm, we have all those cases of intermittent discharges or series of effects from an (apparently) single stimulus, *e.g.* Ritter's tetanus, Wundt's tetanus, and the strychnine tetanus. These are rhythmic expressions of inertia, comparable to the oscillations of the jelly consequent on a single tap given to it. Functional inertia may express itself in the *maintenance* of a certain rhythm of discharge of impulses, as has been brought out by Professors Horsley and Schäfer in their experiments upon the normal rate of discharge of cells of the spinal cord. They showed that whatever was the rhythm of stimulation, provided it was ten per second or more, artificially imposed upon the nerve-tracts proximal to the cells, the rhythm of discharge was always ten per second, *not more.* The protoplasm of these spinal cord cells has *its* own phase of physiological insusceptibility, its "refractory period," and no artificial rate of stimulation will accelerate the rhythm (provided the stimulation be below a certain intensity)—this is functional inertia. The anabolic inertia of the cells of the reflex "centres" of the spinal cord must be the principle underlying the insusceptibility to single stimuli, and the necessity for "summation" of stimuli before the

[1] "General Physiology," p. 401. Macmillan: London, 1899.

action takes place. The nervous system, in common with other tissues, shows us many cases of insusceptibility, *e.g.* to drugs and poisons. The idiosyncrasy of one man to a given drug in that he is peculiarly insusceptible to it, is as well expressed by saying that, owing to the magnitude of the functional inertia of some tissue of his, the drug has no influence, while owing to the smallness of the inertia of the tissues of another man, the drug has considerable influence. The man whose cerebral protoplasm has much anabolic functional inertia, *e.g.* with respect to chloroform, will take a longer time to become anæsthetised by that drug than some other man whose protoplasm has less.

III. In the more characteristically psychic sphere, examples of functional inertia, psychic inertia, are numerous. A person appears taller than he otherwise does, if his clothing shows longitudinal striping—the idea of extension up and down occupies the mind, and we carry more of it over into the estimate of the person's height than we would have done had he been differently dressed—by its inertia (active phase) a given idea imparts to the subsequent one some of the characters of itself.




So in connection with the illusion as to the relative lengths of the lines *A* and *B*—the lines are of equal length, but *B* appears greater than *A*. Mental functional inertia seems to be responsible for the erroneous estimate. Owing to the manner in which the short converging lines turn back, as it were, upon the line *A*, they suggest the ideas of "backwards," "the end reached," "limited," and

so on, so that in estimating the length of *A* there is a pre-existent disposition to see it short, limited, etc., evidently the effect on the notion (length of *A*) due to the (mental) functional inertia of the preceding idea—"end reached," "bounded," "limited," etc. Similarly, the short diverging lines on the ends of *B* suggest "extension," "outwards," "boundaries not fixed," and so on, hence we carry over into the next idea—length of *B*—by mental functional inertia some disposition to see *B* "long," "going outwards," or "upwards," "not bounded," and so on. Since in the notion, length of *A* by itself, there is a latent tendency to under-estimation, and in the notion, length of *B*, a tendency to over-estimation, we at once judge *A* shorter than *B* when the two ideas are present to the mind simultaneously.

The well-marked tendency to think, say, or do what has been thought, said, or done before—to yield to habit, to the familiar—is nothing other than the expression of the functional inertia of psychic activity. Quite a number of people, for instance, will say "thirty or forty" for "thirty or fewer" when in reading aloud they meet the latter phrase. The mental condition in hypnotism, where the suggestion has started a train of thought adhered to with astonishing tenacity, and worked out to its uttermost consequences in spite of all possible distractions, is surely well expressed as the inertia of psychic activity: the inertia—the obliviousness—has been by artificial means morbidly increased for the time being: it is an insusceptibility to all but a few stimuli, and may amount to actual sensory paralysis. So, too, it is mental inertia that causes certain persons to be refractory to hypnotic influence. But examples could be indefinitely multiplied. Are not bigotry and fanaticism respectively the inertia of psychic rest and the inertia of psychic movement? Superstition and an unenlightened dislike to change are surely due to the inertia of psychic rest. The lingering of superstition from generation to generation is an example of psychic inertia in the race—all failure to respond to intellectual environment, must arise from mental inertia. In the child-mind it is owing to the feeble degree of inertia of psychic rest and of psychic activity that it

exhibits so high a degree of suggestibility. The child-mind maintains for so short a time, and in so slight a fashion, any one course of action or set purpose, that almost any fresh idea (suggestion) from parent or play-mate can divert it into a fresh channel, and the new idea, in turn, can be easily supplanted by some other notion newer still. There is so little inertia of position belonging to the idea in possession of the mind that the idea can be very easily supplanted, and the new idea has so little momentum that it can be at once turned out of its course by some new thing. Thus a volatile nature is one with but slight mental inertia of movement; a "dogged" temperament is one with much. The great obstinacy of the uncultured, and the "fixed delusion" of the lunatic are cases of excessively developed inertia of psychic rest. Surely psychic anabolic inertia is responsible for the lack of correspondence between sensation and stimulus as formulated in the Weber-Fechne law; certain increments of stimulus *not* giving rise to any increase of sensation until certain intensity-limits are passed. The insusceptibility that exists through a whole series of increments of stimulus, from the last sensation-producing increment to the next one, seems one more instance of psychic inertia. Lastly, the differences in duration of reaction-time ("personal equation") between various kinds of people are directly due to the differences in degree of the psychic anabolic inertia of their cerebral cells.

The graphic record of reaction-time gives us a measure in fractions of a second of the degree of their cerebral anabolic inertia, but their whole characters are a daily and familiar exposition of psychic inertia of rest or of activity respectively.

## THE LATENT LIFE OF PLANTS.

By R. A. ROBERTSON, M.A., B.Sc., F.R.S.E.

(Read 13th February 1902.)

The manifestation of plant life depends on certain external conditions, and in reference to these it is usual to make a distinction between the tonic and the stimulant effects. That particular combination of influences necessary

to induce and maintain growth is regarded as tonic, while any variation in these conditions produces growth variations, and is described as stimulant. It has to be remembered, however, that the difference here pointed out is, after all, one of degree and not of kind. From this point of view plant growth is a continuous manifestation of irritability, and it is this power of responding, of manifesting irritability that, in the first instance, enables us to distinguish between a living and a dead organism.

We take a stimulus here in its widest sense, as defined by Pfeffer ("Physiology," p. 11), as "a push to which the organism responds according to its inherent nature and the means at its disposal," while any result immediately accruing or appearing only after days or weeks have elapsed is a manifestation of irritability.

When a motor stimulus is applied to resting plant protoplasm, as is well known, an interval of time elapses before the movement begins; and conversely, when the stimulus is one to inhibit a movement already in progress, a corresponding interval passes before inhibition. These intervals are the familiar latent periods, and it is during these periods that the protoplasm exhibits its property called functional inertia (Harris, Brit. Med. Assoc., Aug. 1900). In the first case, it is functional inertia of anabolism; in the second, that of katabolism. One or other is always in evidence after a stimulus, and in many cases both, following in the order either of (1) anabolism, (2) katabolism, or the reverse. Plant physiology supplies copious examples of both phases.

External influences are efficient as growth stimuli only when they are applied within definite limits of intensity. We have thus to recognise the existence of stimulatory limits, maxima and minima. The protoplasmic molecules have their own limit of swing and rate of vibration, and no amount of pushing, *i.e.* of stimulation, will induce them to swing farther or faster. At the outset we are met with a "refractory period"—a non-responsiveness of living matter beyond certain limits. This is the expression of its functional inertia.

We take up seriatim cases of plant irritability with

the view of exhibiting this interesting property in its many varied aspects.

*Gravity.*—When a stem laid horizontally continues to grow in the same direction for some time before curving geotropically it exhibits functional inertia of anabolism. The time value of the inertia varies for different members, from a few minutes (Darwin, "Nature," vol. 65 p. 44) to an hour or more (Detmer, "Physiology," p. 443). When the shoot curves past the vertical—the point of zero stimulation,—the other phase of katabolic inertia is presented. This is, to use Harris's analogy, the door swinging after you have ceased to push it. In those cases where a sense organ has been proved to exist (Pfeffer, "Annals of Botany," viii. p. 317, and Darwin, "Annals of Botany," vol. xii. p. 567), from which the impulse is transmitted to a responsive organ, transmission time—including Czapek's exposition and presentation period—has to be deducted from the reaction time to obtain the time value of the inertia.

To place an upright support in the way of a twiner whose movement is due in part at least, if not entirely, to lateral geotropism, is a case of mechanically inhibiting a movement. If the support be removed before growth has rendered the curvature permanent, the revolving movement recommences, but only after a latent period, varying from a few hours to a few days (Darwin, "Climbing Plants," p. 21). This is katabolic inertia.

*Light and darkness.*—Light acts as a stimulus in virtue of its intensity and also of the direction of its incident rays. A plant which has been growing rapidly during the night does not have its growth retarded immediately on the approach of daylight, nor when placed in darkness after being exposed to light is its growth immediately accelerated. In both cases, for an hour or more (Sach's "Physiology," p. 559; Vines' "Physiology," p. 395), in virtue of the functional inertia of the protoplasm, the previous conditions continue, and the growth curve continues to rise in the first instance and to fall in the second.

When *Bacterium photometricum* (Vines' "Physiology," p. 523) is placed in darkness its movements are inhibited,

and when brought into light they recommence, but in neither case is the manifestation of irritability immediate. In the first instance, there is a period of katabolic, and in the latter of anabolic inertia, and the time values of these periods vary with the intensity of the light.

Concentrated sunlight will inhibit the streaming of protoplasm of *Elodea* after five to six minutes, while recovery takes place in fifteen minutes to an hour (Ewart, "Annals of Botany," xii. p. 385). Here we have both phases, first the katabolic and then the anabolic.

When $CO_2$ assimilation in *Elodea* has been inhibited by prolonged darkness, the recovery on exposure to light requires from twenty minutes to half an hour (Darwin, "Proc. Camb. Phil. Soc.," ix. 338). This is the expression of the katabolic inertia.

In what Wiesner calls photo-mechanical induction of heliotropic heterauxesis, we have interesting cases where the functional inertia amounts to a *physiological insusceptibility.* Thus, in order to induce the maximum heliotropic curvature a definite time exposure is necessary, and no additional exposure will cause the organ to curve farther or faster. For the cress and vetch, Wiesner (Vines' "Physiology," p. 435) found the period of photo-mechanical induction to be about one-third of the reaction period, *i.e.* something over eight minutes for the former and under twelve minutes for the latter. Following this came the period of anabolic inertia lasting from twenty-five to thirty-five minutes, after which curvature began.

A parallel case is presented in Lewes' researches ("Annals of Botany," vol. xii. p. 420) on the movements of the chloroplast of *Mesocarpus.* Lewes found that a definite time exposure—one and a half minute in sunlight and two minutes in diffuse light—was necessary to bring about the greatest possible movement of the chloroplast, viz. rotation through 90°. Further, a definite time was necessary for the performance of the movement, viz. half an hour in the first instance, and twenty minutes in the latter. This supplies a very lucid demonstration that the protoplasmic molecules have their own rate and extent of swing, and are not to be induced to pass it. It is the case of the free wheel bicycle pedal, which no amount

of pushing will cause to pass the dead point—the dead point here being the horizontal for diffuse light and the vertical for sunlight.

Under this category also come cases of attunement of Algæ to light of particular intensity (Detmer, "Physiology," p. 426).

*Temperature.*—Temperature variations induce growth variations in the course of a few hours. This period of anabolic inertia is relatively short when contrasted with that following variations in the other tonic conditions, such as pressure of oxygen or food supply (Pfeffer, "Physiology," pp. 511, 512). A rise of temperature from 15°–20° C. stimulates tulip and crocus flowers to open after a latent period—anabolic phase—of five minutes or so. If while opening the temperature be reduced, they close, but not immediately; in virtue of their katabolic inertia they continue to open for a few minutes. Pfeffer states that the tulip is sensitive to a difference in temperature of ½° C, while the crocus to 2° or 3° C. The former thus has much less functional inertia to change of temperature than the latter.

At 46° C., protoplasmic streaming is inhibited in *Elodea* after the short period of two minutes—katabolic inertia—while recovery requires 1–2 hours, a relatively prolonged period of anabolic inertia (Detmer, "Physiology," p. 420).

In response to the directive stimulus of the heat rays, *Lepidium* seedlings execute negative thermotropic curvatures, while *Zea* seedlings exhibit positive thermotropism. In both cases the curvature begins only after the lapse of a few hours—anabolic inertia.

*Contact.*—Taking cases of contact irritability as exemplified in tendril climbers, insectivorous, and sensitive plants, we find that they display functional inertia under varied aspects, *e.g.* phenomena of latent and refractory periods, physiological insusceptibility, and specific idiosyncracy. In the different species of *Drosera* the latent period varies from ten seconds to twenty minutes (Darwin, "Insectivorous Plants"), while in the tendrils of the *Passifloreæ* it may be from a few seconds to an hour (MacDougal, "Annals of Botany," vol. x. p. 373). In contrast to the above, *Dionæa* and *Mimosa* have relatively so little ana-

bolic inertia that the response to contact appears immediate. On the other hand, the tendrils of the *Ampelideæ*, with relatively little irritability, display much anabolic inertia, the latent period lasting for two hours or more.

Cases of physiological insusceptibility appear in relation to particular amounts of stimulus. Thus, while a single light touch elicits a response in *Mimosa*, for *Dionæa* it has to be repeated, *i.e.* a kind of double impact is necessary, according to Macfarlane. *Drosera*, on the other hand, exhibits a refractory period, inasmuch as the efficient stimulus is a continued series of such impacts, *i.e.* a pressure; while in tendrils, according to Pfeffer, the stimulus is contact with a rough surface, *i.e.* a series of impacts simultaneously applied at discrete points of the sensitive organ.

*Injury.*—Cases of traumatic stimulation are instructive both on account of the varied manifestation of irritability and of the great range in the time value of the latent period. This, as we find, may vary from a few seconds to as much as a week, and in some cases may be artificially prolonged to eight days.

If we take fertilisation as a case of stimulation (Pfeffer, "Physiology," p. 55), we may regard it as of a chemico-vital and traumatic character. Thus, as the spermatozoid breaks the continuity of the plasmatic membrane, and ploughs its way through the cytoplasm, we find as reaction to the traumatic stimulus the formation of a protective cell-wall on the egg. This takes place after a period of anabolic inertia varying from ten minutes in *Fucus* (Farmer and Williams, "Phil. Trans. Roy. Soc.," 1898, p. 625) to a few hours in other forms.

Again, a cell membrane may appear around a plasmolysed protoplast after fifteen minutes—or more—period of anabolic inertia (Pfeffer, "Physiology," p. 483).

Injury to the maize epidermis stimulates protoplasmic streaming after fifteen minutes to an hour (Detmer, "Physiology," p. 420). Lateral injury to the root apex induces traumatropic curvature and regeneration of the root tip after a latent period of an hour or so (Spalding, "Annals of Botany," viii. p. 423). By encasing the root in a plaster-cast, or lowering the temperature, the curvature is

prevented, and the anabolic period may be prolonged for eight days. A fever reaction is induced in massive tissues, as potato tubers, by incised wounds after a reaction period of two hours or so (Richards, "Annals of Botany," x. p. 531, and xi. p. 29). According to Townsend ("Annals of Botany," xi. p. 515), amputation of a small piece of the root apex is followed after a latent period of twenty-four hours by a retardation of growth in the root and an acceleration of growth in the stem. The long latent period of five or six days elapses between the application of the traumatic stimulus and the manifestation of irritability—a peculiar healing reaction—in isolated leaves of *Prunus lauro-cerasus* (Blackman and Matthaei, "Annals of Botany," xv. p. 533).

*Oxygen.*—Absence of free oxygen inhibits streaming in *Chara*, but only after a considerable period of katabolic inertia (Ewart, "Jour. Lin. Soc.," xxxi. p. 421; also Farmer, "Annals of Botany," x. p. 286), while obligate aerobia continue to move from five to sixty minutes in the absence of free oxygen (Pfeffer, "Physiology," p. 569).

The list of examples might be indefinitely extended. Interesting cases of physiological insusceptibility are supplied in Arber's researches on the $CO_2$ assimilation of halophytes ("Annals of Botany," xv. pp. 39 and 669), in the thermo-secretory phenomena of nectaries (Pfeffer, "Physiology," p. 286), in Pfeffer's "Chemotactic Application of the Weber-Fechner Law," in the vital phenomena of parasites, fungal and other. On the other hand, Ewart's researches on assimilatory inhibition ("Jour. Lin. Soc.," xxxi. pp. 364, 554; "Annals of Botany," xi. p. 439) are a mine of examples of both phases of functional inertia. In many cases the biological significance of the time-value of the functional inertia is of the highest importance. Thus (Ewart, "Annals of Botany," xii. p. 378) mosses have much katabolic inertia to desiccation, and relatively little anabolic inertia to moisture; they continue to assimilate for two to five days during desiccation, and when desiccated they resume operations on moisture being supplied in the short period of a few hours. The same is true of other members of Alpine floras, and the importance of it is manifest.

Passing on to consider the functional inertia of excised and isolated organs, we again find no lack of examples, in

consequence of the lower pitch of vitality and greater individuality of plant protoplasts. As the wheel continues, in virtue of its inertia of motion, to rotate, it may be for a considerable time after the driving gear is slipped, so many plant organs and cell organoids continue to function for a time when isolated. This is a manifestation of their katabolic inertia. Isolated chloroplasts, for example, assimilate for five hours (Ewart, "Jour. Linn. Soc.," xxxi. p. 420); isolated endosperm of *Ricinus* lives and carries on metabolic change for six months (Van Tieghem, "Ann. d. Sc. Nat.," 1876, Ser. vi., T. iv., p. 183), a fact which may be of interest in connection with xenia and double fertilisation. Isolated scutellar epithelium secretes enzymes and corrodes starch grains (Brown and Morris, "Jour. Chem. Soc. Trans.," vol. lvii., 1890, p. 494). Isolated fragments of swarmspores move, and of cytoplasm stream, while Demoor found that nuclei continued their mitosis after the cytoplasm was killed by $CO_2$ or chloroform (Pfeffer, "Physiology," p. 52). Again, isolated leaves of *Drosera* continue active, translocation takes place in heads of cereals (Pfeffer, *loc. cit.* p. 585), and ripening in fruits after separation from the parent plant; and oak galls continue their internal metabolic changes when removed from the tree (MacDougal, "Physiology," p. 64).

In the consideration of rhythm or periodicity we again meet with interesting examples of inertia. Thus, in virtue of their functional inertia, plants continue to exhibit daily periodicity of growth for periods varying from two days to as many weeks in continuous darkness. Some trees, like the oak and beech of temperate regions, which exhibit a seasonal periodicity, retain that periodicity when removed to countries where the vegetation is evergreen; they do so in consequence of their great amount of inertia. Other temperate trees, again, possessed of a smaller amount of inertia, lose their periodicity after a time and become evergreen, *e.g.* the plum and the peach. On account of possessing relatively little inertia, again, some plants will "force" and flower out of season, others with more inertia are refractory. By cold storage—artificially keeping the plant in a condition of anabolic inertia—the refractoriness of the latter may be in some measure overcome.

Plants which have a daily periodicity of movement, such as sensitive plants, daisy, and so forth, exhibit post-stimulant periodic movements in continuous darkness. This is one expression of their functional inertia.

Evidence on similar lines can be adduced from the interesting experiments of Darwin and Pertz ("Annals of Botany," vol. vi. p. 425), and others, on induced rhythm in different organs.

*Polarity*, according to Detmer ("Physiology," p. 507), may be regarded as an "after effect phenomenon induced by gravitation and stretching beyond the life of the individual, as a phenomenon of inherent or stable induction, and therefore an inheritable disposition." For the more or less indelible impression of this character by summation of effects, the property of functional inertia would be a necessary preliminary. On account of their greater functional inertia, polarity is more indelibly stamped on some plants than on others, and in the latter, in consequence of their smaller degree of inertia, it is possible to alter the polarity by the influence of external conditions. It would seem that in the acquirement of characters generally by living matter, *i.e.* in the "education" of protoplasm, functional inertia is a factor of great importance.

The time taken for summation of effects, for the education or acquirement of characters, will depend on the amount of inertia displayed by the protoplasm in relation to the particular stimulus. Time is an element of the process, and this represents the time value of the functional inertia. The following cases might be cited as bearing on this point in particular, but additional examples will present themselves to every botanist.

Stahl ("Bot. Zeit.," 1884), by gradually adding glucose to water in which *Æthalium* plasmodium was growing, succeeded in growing it ultimately in a 2 per cent. solution, which would, under ordinary circumstances, have killed it.

It is a well-known fact that sporeless and other varieties of bacteria may be obtained by continued cultivation in particular nutrient solutions under special conditions.

Again, it has been pointed out that some plants can be

acclimatised, but others not at all; the former have relatively little inertia as compared with the latter.

Protoplasm can be gradually acclimatised to an atmosphere of 1 part oxygen to 4 of $CO_2$, which, when directly applied, inhibits all movement (Lopriore; MacDougal, "Physiology," p. 57).

Consideration of these cases of single stimuli makes it clear that plant protoplasm has not always the same amount of functional inertia, and further, that the time value of the inertia varies very widely in different organs in respect of the same stimulus. Thus it ranges from periods of time measured by seconds to hours or days, and it has been indicated that it is possible to artificially lengthen the period. There still remain to be considered those cases where the amount of inertia is so considerable that more than one stimulus is necessary to elicit a manifestation of irritability, and where, furthermore, the inertia assumes the character of a physiological insusceptibility, inasmuch as the reaction is only called forth by a particular combination of stimuli.

Pierce ("Proc. Calif. Acad. Sc.," Ser. III. ii., 1901, p. 83, also "Bot. Central. Bd.," lxxix., 1902, p. 36) describes a case of redwood stumps producing white suckers. No chlorophyll was developed, according to Pierce, because of the low inhibitory temperature; the shoots were parasitic on the underground parts of the tree. The temperature rose, and the inhibitory was replaced by an inducing stimulus, but yet no chlorophyll was developed. From our point of view the plants were thus manifesting great functional inertia of anabolism. Only when a second stimulus came into action (a change in the food conditions) was there a response in the production of green leaves. The anabolic inertia was here so great that *two* stimuli of a tonic character, conditions of temperature and food supply, were required to elicit the manifestation of irritability.

A more extreme case still is furnished in the winter buds of *Hydrocharis*. Terras found ("Trans. Bot. Soc. Edin.," xxi., 1900, p. 318) that if covered up these buds could be kept in the dormant condition, that is in a condition of anabolic inertia, for at least *two* years. To induce germination, heat, light, and oxygen were necessary. So

great was the anabolic inertia that *three* stimuli of a tonic character were required to elicit a manifestation of irritability, in this case—growth.

This example forms a transition to the condition of the dry resting seed, which may be taken as exhibiting the most extreme case of functional inertia. The *Hydrocharis* buds when dormant are not only living but are giving manifestations of life, inasmuch as they continue to respire to a slight extent throughout their dormant phase (Terras, *loc. cit.*). In the dry seed we have an organism that is living but is affording no indication of life, inasmuch as it does not respire. If we regard respiration as merely an episode of nutrition (Giglio-Tos, "Les Problemes de la Vie," p. 54; "Trans. Bot. Soc. Edin.," vol. xxii., 1901, p. 45), this non-respiration is what we might expect. That no respiration takes place in the dry seed has been conclusively proved by several interesting experiments by Kochs (Verworn, "Physiology," p. 132); Romanes ("Proc. Roy. Soc.," vol. liv., 1893, p. 335); De Candolle ("Arch. Sc. Phys. et Nat.," viii., '99, p. 517); Brown and Escombe ("Proc. Roy. Soc.," lxii., '97, p. 160); and Thiselton-Dyer ("Proc. Roy. Soc.," lxv., '99, p. 361). Respiration, as Chodat ("Bull. d. Herb. Bois.," vol. iv., 1896, p. 894) points out, "is not a necessary condition of life, but only a condition of its manifestation," for the seed is living although not manifesting life. Even in regard to the manifestation of life, respiration would appear not to be a necessary condition in every case, for, according to Nabokich ("Jour. Roy. Mic. Soc.," 1901, p. 555), it is probable that some seeds can germinate without oxygen. If the air be moist, however, respiration begins, and as the moisture increases the respiration rapidly increases (Kolkswitz, "Ber. Deutsch. Bot. Ges.," xix., 1901, p. 285).

The dry seed may be regarded as an organism whose functional inertia is infinite for any single stimulus, but relatively small for a given combination of stimuli, viz. heat, moisture, and oxygen, and if we add light in certain cases to the combination the response is still further accelerated; for Heinricher ("Ber. Deutch. Bot. Ges.," xvii., 1899, p. 308) finds that seeds of *Veronica peregrina* germinate 5–8 days sooner in daylight than in darkness.

To elicit that manifestation of irritability which we call growth, and which we take as evidence of life in the seed, three tonic stimuli are necessary. Not only must these be applied simultaneously, but they must be applied in the proper intensity. If any one or all the combination be applied in too great intensity, life may be destroyed. On the other hand, there is reason to believe that a single stimulus may be separately applied at an intensity far in excess of the limits, and yet produce no fatal result. In the experiments of Brown and Escombe (*loc. cit.*) seeds were subjected for 110 hours to the temperature of liquid air—183° to −192° C., and in those of Thiselton-Dyer, were immersed for six hours in liquid hydrogen—250°–252° C., and yet germinated. Jencic ("Œster. Bot. Zeit.," li., 1901, p. 268), again, found that when air-dried seeds were subjected to a temperature of −18° C., their germination was accelerated.

The latitude in regard to trespass of the upper cardinal point of temperature appears to be more limited. Dixon ("Nature," lxiv., 1901, p. 256), however, finds that of seeds, specially *Medicago sativa*, exposed for an hour to 110° C., and a further hour to 121° C., 10 per cent. germinate. Jodin ("Compt. Rend.;" 129 (1899), p. 893) states when seeds of peas and cress are heated at 60° C. for twenty-four hours, and then for ten hours at 98° C., 30–60 per cent. retain their germinative power; further, these seeds in sealed tubes containing some water-absorbent, such as quicklime, will germinate after being submitted for twenty days to a temperature of 40° C. If we seek in the animal kingdom for cases to parallel the resting seed in its condition of "*vie latente*," or *scheintod*, we find them, perhaps, in the desiccated state of tardigrada and rotifera, and very likely it will be found that these organisms, when thoroughly desiccated, can withstand the same extraordinary tests as the dry seed.

As to the molecular condition of the living matter of the dry seed, little can be said. De Candolle compares it with that of an explosive mixture: so long as the necessary conditions are unapplied the mixture remains quiescent, and will so remain for an indefinite period. Brown and Escombe are of De Candolle's opinion, and hold that the

protoplasm has passed from the kinetic to the static condition, and that under such circumstances, the low temperature being maintained, "it is difficult to see why there should be any limit to its perfect stability."

Protoplasm, when manifesting life, contains much water, and desiccation only suspends the vital manifestation, but does not, according to Giglio-Tos (*loc. cit.* p. 101), destroy the living substance. The composition of the molecules remains unaltered because the water does not enter chemically into their constitution, but is only physically held as water of adhesion and of capillarity. The molecular movement ceases because of the absence of the intermolecular water, which serves as the medium of nutritive exchange. This view is essentially the same as that of De Candolle and Brown and Escombe, and according to it the possibilities as to the duration of the latent life of seeds appear very considerable. To this, however, there would appear to be some limit. Gain, *e.g.*, finds ("Comp. Rend.," cxxx., 1900, p. 1643) that in mummy-wheat and barley, while the external appearance and chemical composition of the endosperm are unaltered, the embryo itself has undergone such marked chemical change as to be incapable of germination, and he concludes that the latent life has long ago expired. Of course, it is just possible that the seeds were chemically treated before being put into the mummy-cases by the Egyptians. There is no doubt, however, that seeds may retain their germinative capacity for very considerable periods of time.

Sir William Thiselton-Dyer, in discussing the physiological bearing of his liquid hydrogen experiments on the phenomena of life generally, points out that, if the molecules of living matter be regarded as reduced to the static condition, resting protoplasm is in the condition of an explosive, and there is no criterion whereby to distinguish living matter in the static condition from dead substance.

This would appear to depend on the particular theory held as to living matter. In a purely chemical theory the difficulty is not an insuperable one. The explosive can always be distinguished from the inert mass by applying the proper conditions, just as one chemical substance can be distinguished from another by its reactions to particular

tests. On a chemical theory, such as that of Giglio-Tos (*loc. cit.*), the molecule of living matter is distinguished as living because it has a special chemical constitution, in virtue of which it can undergo a specific chemical reaction under certain conditions of environment. Given the necessary internal chemical composition and the necessary external conditions, the chemical reaction follows, externally visible as that manifestation of irritability called growth.

Obituary Notice of the late Charles Stuart, M.D. By Commander F. M. Norman, R.N., Fellow, Botanical Society, Edinburgh.

(Read 10th April 1902.)

Deep and widespread regret was felt throughout the Border district, and in many places beyond its limits, when the death of this much-esteemed medical practitioner took place at his residence—Hillside, Chirnside, Berwickshire,—on 12th February 1902, in the seventy-sixth year of his age. His demise deprived me of an intimate and deeply valued friend of a quarter of a century's duration, and the botanical and horticultural world of one of its chief ornaments and most devoted adherents. Dr. Stuart was "a man—every inch of him," and his cheery welcome, genial presence, manly character, warm, kindly heart, and enthusiasm for Flora could not fail to impress all who had the privilege of his acquaintance. Certainly his departure has created a void in the circle of my own friendships which can never be replaced. He lived a highly useful, blameless, affectionate, Christian life, which, to the great advantage of his family and friends, was prolonged for some years beyond the proverbial "three-score and ten."

Until eighteen months or so before his death he had always enjoyed good health, and his robust frame and excellent constitution showed no signs of breaking till he contracted the ailment which ultimately, after much suffering, laid him low.

Amid many tokens of respect and affection from a large concourse of mourners, he was laid to rest in the

churchyard of the old Parish Church at Chirnside, within sight of the little garden which had been his chief delight for so many years—the garden whence had emanated the numerous productions which had so delighted his friends, enriched the horticultural world, and .procured him such distinction in horticultural circles.

Dr. Stuart, it is well known, was a representative of a collateral branch of the ancient Earldom of Moray, being a direct lineal descendant of the third son of the fourth Earl. His father, John Alexander Stuart, died in 1869; and his son Charles, the subject of this memoir, was born at Woodhall, near Edinburgh, on 30th March 1825; married, in 1851, Georgina, daughter of the late Rev. John Edgar, minister of Hutton, Berwickshire; and is survived by his widow and a large family of sons and daughters to mourn his loss.

He was educated at the Edinburgh Academy, and at the University of Edinburgh, where he took his degree as Doctor of Medicine in 1846, and was also a Licentiate of the Royal College of Surgeons in Edinburgh. Two years after qualifying professionally, he settled at Chirnside, where he practised for fifty years—not until quite the close of the century having sought the services of a coadjutor and successor. His talents, skill, and energy secured for him a large and successful *clientèle*.

From an early date he was appointed Medical Officer for Chirnside and adjacent parishes, and did excellent service in that capacity. The poor found in him a true friend, for he was always solicitous in securing their interests and comforts. He was an Extraordinary Member of the Royal Medical Society in Edinburgh.

The Free (now West United Free) Church of Chirnside were proud to number him among them, and he took a warm interest in the life and work of his church. His political views were broad-minded Liberal.

From early years Dr. Stuart was an enthusiastic student of nature—especially of plants and trees, birds, and the phenomena of the seasons. He was an observing man, and, as he drove about the country on professional routes, nothing escaped his eye, and he always had something instructive and interesting to write or say about his

observations. He became a Fellow of the Botanical Society of Edinburgh on 10th July 1884, and of the Scottish Alpine Botanical Club in 1874, of which he was an enthusiastic adherent and a well-known and welcome figure. In fact, he was too enthusiastic, for there is but too good reason to fear that the incipient ailment from which he suffered was aggravated beyond recovery by his injudiciously insisting upon travelling to take part in a late meeting of that, his most favourite, Club.

With that Club he discovered and secured two prizes, viz. a beautiful rose-pink variety of *Veronica saxatilis* on the Breadalbane Hills, near Killin; and in Connemara, in 1890, a new form of heath, named *Erica Tetralix Mackiana Stuartii*. Having joined the Berwickshire Naturalists' Club in 1854, he became its President for the year 1873, and to its Proceedings from time to time contributed a large number of interesting Papers on subjects connected with Natural History.

Dr. Stuart's achievements and successes in horticulture were numerous and important, and secured for him many well-deserved honours from Horticultural Societies, among them being the dedication to him of one of the volumes of "The Garden," the leading paper of that "ilk" in England.

Evidently he devoted his attention to the Pansy very early (his favourite flower), for as long ago as 1854 he was a successful competitor at The Scottish Pansy Society, and in 1859, with the same flower, gained several important prizes at their show. In 1874 he began to turn special attention to hybridising, which was his specialty, wherein, in certain directions, he may be said to have been *facile princeps*.

He began his experiments by crossing the Pansy with the old *Viola cornuta* of gardens, and produced many beautiful hybrids, which had the merit of being true perennials and continuous bloomers, six of them having obtained a First-class Certificate from Chiswick, in 1876.

He raised many beautiful Violas—especially a light yellow, rayless one—which were greatly admired. In May 1880, by crossing *Aquilegia Witmanni* with *A. glandulosa*, he obtained the beautiful Columbine which perpetuates his name—*Aquilegia Stuartii*.

He was also successful in Primulas and Polyanthuses, particularly in gold-laced varieties of the latter; in raising an excellent self-stage red Auricula; and—to the envy, perhaps, of many amateurs and professionals—of cultivating with conspicuous success numerous rare and difficult to rear Alpine Ferns and other Alpines.

Latterly he turned his attention to the improvement of *Trollius* (globe-flower), and crossed the American with the European species with good effect; and he also produced some beautiful varieties of the Daffodil, and was the fortunate discoverer of a unique strain of that favourite flower, growing wild, or naturalised from ancient times, which is known as The Whitehall Daffodil.

It was a real treat to a kindred spirit to ramble around Dr. Stuart's extraordinarily well-stocked garden with its owner, where, in expatiating upon his favourites, he would "talk down hours to minutes." It was ever a marvel to me how, in so small an area, such a vast collection of plants and flowers were always flourishing, and still there was space for experimental stations!

The lamented doctor was a man of much literary taste, and, in addition to his numerous contributions to the Berwickshire Club, and to certain Journals, wrote a pamphlet on the Yetholm gipsies.

Mr. President and Gentlemen,—our Society, as well as other Societies, is distinctly the poorer by the decease of Dr. Charles Stuart, for, if not exactly a nobleman (though he was not far from being one), he was emphatically a noble man, whose name was an adornment, not only to our roll, but to the longer, more ancient, and more comprehensive one of the Sons of Caledonia.

## Notes from the Archives of the Botanical Society on its Origin, History, and Privileges. By Symington Grieve.

(Read 10th April 1902.)

The Botanical Society was formed on the 17th of March 1836, at a meeting held in Professor Graham's Classroom at the College, Edinburgh, and was presided over by Dr. J. H. Balfour (afterwards Professor J. H. Balfour),

and it was resolved to form a Society, with Professor Graham as President, and Mr. James M'Nab, Curator. An Herbarium and Library were to be formed, and donations of plants and books received, and also plants and books to be purchased. This work was carried on with great energy, and the Society immediately took a position in the botanical world, which made it of great use, not only to its members, but to the University of Edinburgh.

From its inception the Society was closely associated with the Royal Botanic Garden, at which it has, during each year of its existence, by the courtesy of the Professor of Botany, held its three summer meetings—the first of these having taken place on 12th May 1836. As it seemed desirable to the President and Council of the Society that they should become more fully acquainted with the history of the Society and its relation to the University and to the Royal Botanic Garden, the following notes have been extracted from its archives:—

*Amalgamation of the Botanical Society's Herbarium and that of the College, etc.* Also regarding the Botanical Society's Library.

At a meeting of the Society, held in the Royal Institution, 8th November 1838, "The Treasurer read a copy of a Petition, signed by the majority of the Council of the Botanical Society, dated 30th July 1838, and presented to the Town Council of Edinburgh, praying that, as Patrons of the University, they would consent to a union between the Botanical Society's Herbarium and that belonging to the College. A letter from the President to the Town Council annexed to the Petition, containing a recommendation of the proposed union, was also read. The Treasurer stated that the Petition had been favourably received by the Patrons, and remitted by them to the Senators for further consideration. The President mentioned that the Petition had been duly considered by the Senatus, and a Committee appointed, of which he was Convener, to arrange the terms for carrying into effect the desired union, and that he had no doubt the matter would, in a very short time, be satisfactorily adjusted."

At a meeting of the Committee of Management of the Botanical Society, held at 62 Great King Street, 1st December 1838, at 2 P.M., "The President stated, with reference to the proposed union with the College Herbarium, that he was not aware that any serious obstacle now existed to prevent its being carried into effect, and that, as Convener of the Committee of Senators to which the matter had been remitted, he would call an early meeting to endeavour to get the arrangement carried into effect with as little delay as possible."

At the ordinary meeting of the Botanical Society, held 10th January 1839, it was reported by the Committee that "they had the satisfaction of stating that the arrangements, which have for some time been in progress with the Patrons and the Senators of the University, have now been brought to a close, and that both of these bodies have unanimously agreed to the union of the College Herbarium with that belonging to the Botanical Society on the terms proposed. In the course of the following week an Extract will be obtained from the Records of the Town Council containing the terms of the arrangement, which will be submitted to the Society at the next ordinary meeting.

"In the meantime it may be satisfactory to state that the Society will thus obtain the (*permanent*) *use of apartments* in the University already fitted up for the reception of their Herbarium, and that the collections belonging to the University may now be arranged along with those of the Society."

At the ordinary meeting of the Society, held 10th January 1839, the Secretary invited the members to assist him with work at the Society's Rooms in the College daily from ten to to four o'clock.

At the ordinary meeting of the Society, held 14th March 1839, it was reported that the Committee of Management have to notice with peculiar satisfaction the union which has taken place with the College Herbarium — the whole of which, along with the use of the apartments and cabinets in which it is contained, has been *conveyed over to the Society as the perpetual Curators of it*, with permission to arrange the specimens

and distribute the duplicates as they shall think proper.

The following extracts from the Minutes of the Town Council of the City of Edinburgh explain what took place and what arrangement was made:—

Excerpt from Minute of Meeting of the Town Council, 9th January 1839.

Read a Report by the College Committee to which was remitted Memorial and Petition of the Botanical Society; which Memorial and Petition, Letter from Professor Graham thereto appended, and Report of the Committee are of the following tenor:—

To the Honourable the Patrons of the University of Edinburgh, the Memorial and Petition of the undersigned Office-bearers of the Botanical Society, for themselves, and in name of the Society, humbly showeth—

That the Botanical Society was originated in March 1836 by the Professor of Botany and some of the more advanced cultivators of this science in the city and neighbourhood.

The objects for which it was instituted were threefold—

(1) To form a general Herbarium, on scientific principles, for the use and information of members, as well as all other students of Botany.

(2) To establish a system of exchange, by which plants from every country should be brought to Edinburgh as to a common centre, and from thence as widely dispersed among those who should enrol themselves as applicants for these, and the terms prescribed; and

(3) To promote, by correspondence, essays, and other means, a well regulated taste for the study of Botany, an accurate inquiry respecting the phenomena of vegetation, and a general investigation into the properties and uses of plants.

That the Society, which at its origin consisted but of twenty-one members, has in little more than two years become increased tenfold, its members amounting to about two hundred, of whom twenty-six are honorary members, eighty-two resident, sixty-four non-resident, and twenty-seven foreign members, comprehending most of the distinguished names in botanical science throughout the world.

That the objects which the Society had in view at its foundation have already been carried out to a very considerable extent.

A large collection of British and Foreign plants has been acquired (the Countess Dowager of Dalhousie alone having munificently presented the Society with about 1500 species of rare and valuable Indian plants, collected under her own immediate superintendence), and not less than 150,000 specimens from all parts of the globe have been contributed by members, a great proportion of which have again been as widely circulated among public institutions and individual collectors of Herbaria.

That Her Majesty has been graciously pleased to honour the Society by becoming its Patron, and its design has received the general approbation and support of botanists both at home and abroad.

It has also recently provided an appropriate diploma and seal, for the better distinguishing of its members and for attaching them more decidedly to the pursuit of its objects.

That the Society have hitherto, by the kindness of the Professor of Botany, been allowed to hold their meetings (which occur monthly) in the Botanical Classroom, and have also been favoured by him with the use of the apartments in the College appropriated to the University Herbarium for the storing of their collections, and for effecting their annual distribution of plants.

That being now firmly established, the Society are proceeding to classify and arrange their collections, for which purpose they have had an Assistant-Curator, with a salary, constantly employed since the middle of December last, and from the scale on which their operations are now necessarily carried on, they find that his services will henceforth be permanently required.

That the Society, having for their chief object to advance the cause of botanical science, and thereby promote the public benefit, it has occurred to them that the collections of plants which have from time to time been transmitted to the College, and are now deposited in an unarranged state in the apartments above mentioned, so as to be wholly unavailable for scientific purposes, might with great advantage for all parties *be handed over to the Society*, as

well as the permanent use of these apartments, in order that a general Herbarium might be formed in connection with the University, to which all who cultivate the science of botany might have ready access for reference and study.

That the Society, if this were granted, would immediately proceed to classify and arrange the joint collections, and would agree that they should become the University Herbarium, of which, however, the Society should continue perpetual Curators, *but the Professor of Botany, for the time, to be Honorary Curator*, with free access to the collection, whether a member of the Society or not.

That, as the plants belonging to the Society already outnumber those belonging to the College, and as much expense must be incurred in their arrangement and preservation, it is to be hoped that the Honourable Patrons will be satisfied that the Society, in making the foregoing proposition, can have no other object than that of promoting the science they cultivate, and the general interests of the University where that science is so zealously, ably, and successfully taught.

May it therefore please the Honourable Patrons to take this Memorial into their favourable consideration, and accede to the proposal now made on behalf of the Botanical Society, and your Petitioners shall ever pray, etc.

Signed—J. H. Balfour, Vice-President; Robert Kaye Greville, LL.D., Councillor; Dav. Falconer, Vice-President; R. Christison, Vice-President; John Percy, Councillor; Pat. Neill, Vice-President; William M'Nab, Councillor; Wm. Brand, Treasurer; James MacNab, Curator; W. H. Campbell, Secretary.

LETTER from Professor Graham, dated 30th July 1838—

My Lord Provost and Gentlemen,—Having read the foregoing Petition, I beg to express my anxiety that its prayer should be acceded to. Without some such arrangement I feel sure that the University Collection will, as from its first beginning in the period of the late Dr. Hope, remain utterly useless. With such an arrangement I feel equally sure that the Collection as it now stands will be made available, and that before long it will form only a

fragment of a much greater and very valuable collection, which it is very liberally proposed shall become the property of the University.

ROB. GRAHAM, Professor of Botany.

REPORT of the College Committee, dated 27th December 1838.

The College Committee, having resumed consideration of this Petition, and having communicated on the subject with the Senatus Academicus and with the Petitioners, are of opinion that the prayer thereof may be granted by the Magistrates and Council, with these explanations and conditions, viz.—

1. That the Society are to have no right of property in the rooms set apart for the University Herbarium, but that these are to be held by them during the pleasure of the Council and on condition that they shall remove therefrom at the term of Whitsunday on getting six months' previous notice, it being understood that in this event, or in the event of the Society removing because of the apartments allotted for them becoming either inadequate or unsuitable, they are to be entitled to take the collections along with them, and also any cabinets, etc., which they may have fitted up, but with this proviso always, that in either case the collections should continue to be the University Herbarium just as before.

2. That the members of the Senatus shall ex officio have access to the joint collection at all times.

3. That the Professor of Botany, besides being Honorary Curator, shall be entitled for the instruction of his class to take out from the joint collections such portions thereof from time to time as he shall think necessary, the same being always duly restored, and that the Professor of Materia Medica shall have the same privilege with respect to his class.

4. That a Report of the state and progress of the Herbarium shall be annually presented to the Senatus and the Town Council by the day of

JAMES STARK, B.

The Magistrates and Council approved of the foregoing Report, and granted and declared accordingly.

Further Excerpts—

19th May 1839.—There was laid on the table a Report by the Botanical Society on the state and progress of the University Herbarium as at October 1839.

9th November 1841.—Read the following letter from the interim Secretary of the Botanical Society, Edinburgh, 1st November 1841 :—

Sir,—I beg leave to send herewith for preservation to the Council a copy of the Fourth and Fifth Annual Reports for the Botanical Society, containing in Appendix, at page 82, the Society's Report on the state and progress of the University Herbarium, etc., under their charge.—I am, etc., Wm. Brand, Interim Secretary.

In the Report of the Committee presented to the Botanical Society at the ordinary meeting held 14th November 1839, it is mentioned that Mr. Kellerman, the Assistant-Curator, "has been chiefly engaged in cleaning and arranging the various collections which belonged to the College Herbarium. This arduous task has now been nearly completed (a boy having been engaged to assist the Curator and expedite the work).

At the meeting of the Society held in the Royal Institution on 12th December 1839, a letter from Dr. Neill was read, stating that the Patrons of the University had agreed to fit up with gas and size-paint two additional rooms for the use of the Society, and that it was hoped Dr. Traill might be accommodated elsewhere.

Dr. Graham, on resigning the Chair, congratulated the Society on the very rapid progress which it had made.

Dr. Greville, on taking the Chair, thanked the Society. He alluded to the services of their late President, under whose auspices the Society had made such progress, and to whose exertions they owed many of their most important privileges. He reminded them that the Society had, through him, obtained a room for their meetings in the College, and accommodation for their Herbarium; that he had effected a union with the College Herbarium, *and acquired for the Society a (permanent)*[1] *right to the apartments and cabinets*

[1] The right was not permanent, see preceding page (p. 200).

in which it is placed; that through his influence chiefly the patronage of the Queen had been obtained. That the use of a room for the summer meetings of the Society at the Botanic Garden continued to be granted by him.

In the Minutes of the meeting of the Botanical Society, 12th June 1845, it is stated that "*the Office-bearers, together with the Professor of Botany, constitute the regularly appointed Custodiers of the University Herbarium.*"

In a statement read to the Society by its Treasurer, Mr. Brand, at a meeting held at 6 York Place on 14th January 1847, it is mentioned that the balance in the Society's favour was only £14 or £15, and that the Assistant-Curator was unpaid, and it was agreed to pay him £10 as part payment of his salary, and Professor Balfour mentioned that he intended to bring the subject of the University Herbarium under the notice of the Senatus, and he hoped some allowance would be made for the purpose of defraying the expenses connected with it.

At a meeting of the Council, held at 5 Northumberland Street, 4th November 1857, it was remitted to Professor Balfour, along with Mr. P. N. Fraser, Mr. M'Farlane, and Dr. Lawson, to arrange with the Janitor of the College for cleaning and heating the Society's rooms there.

Although hardly a meeting took place without donations of plants for the Herbarium or books for the Library being announced, an important event now happened which enriched the Society considerably. The following intimation explains this. It was read at an ordinary meeting of the Botanical Society, held at 6 York Place, on 10th December 1857:—

"At a meeting of the Wernerian Natural History Society, called by public advertisement, held in the Anatomical Room at the College, on Saturday, 28th November 1857, it was unanimously resolved that the said Society be dissolved, and, if agreeable to the Royal Physical Society and the Botanical Society, that a union be formed with them on the following terms:—

"(1) That the members of the Wernerian Natural History Society should be received as members of the foresaid Societies, preserving the privileges (whether as life

or annual members) which they enjoyed as members of the Wernerian.

"(2) That two-thirds of the funds belonging to the Wernerian Society be given to the Royal Physical, and one-third to the Botanical Society.

"(3) That all books on botanical subjects be given to the Botanical Society. That all other books, except such as may be required for completing works in the College Library, be handed over to the Royal Physical Society.

"(4) That the furniture of the Wernerian Society be handed to the Botanical Society.

"(5) That the specimens in Natural History be transferred to the College Museum.

"(6) That the Minute Books of the Society and other private documents be deposited in the College Library."

To carry the above into effect, Professors Goodsir and Balfour have conferred with the two Societies forenamed, and arranged that, in receiving the property to be assigned to them, these Societies shall undertake all the responsibilities which at present belong to the Wernerian Society.

On the motion of Dr. Sellar, seconded by Mr. Murray, the proposal of the Wernerian Natural History Society was cordially approved of by the Botanical Society and accepted accordingly, and the Council was empowered to carry out the arrangement on the above terms.

At an ordinary meeting of the Botanical Society, held at 6 York Place, on 11th February 1858, it was announced by the Secretary that, at a meeting held on 23rd January 1858, the Wernerian Society had confirmed the resolution of their previous meeting, with only one dissentient, a Dr. Macdonald, who protested that any of the funds or effects of the Wernerian Society should be handed over to the Botanical Society, and threatened legal proceedings.

The members of the Wernerian Society altered the terms of the transfer, so that, in the event of Dr. Macdonald bringing an action, they were to be protected by each of the Societies—the Royal Physical and the Botanical—up to the value of the property each received from the Wernerian Society.

On the motion of Mr. Anderson, seconded by Mr. Fraser, it was agreed that the Botanical Society should

relieve the members of the Wernerian Society as stipulated for under this new condition.

From the Financial Statement of the Botanical Society, November 1857 to November 1858, submitted to the Society 9th December 1858, it appears that the cash received from the Wernerian Society amounted to £72, 5s., and cash obtained for books and forms of that Society, £5, 13s.,—in all, £77, 18s. However, even with this sum handed to it, the Botanical Society was in such arrears with its payments that, after paying its printing account, which was due for three years, and other expenses, they had only a balance of £59, 13s. 8d. to carry forward to the next year.

At a meeting of the Society, held in 5 St. Andrew Square, Edinburgh, on 12th March 1863, the following letter from the President, Professor Douglas Maclagan, regarding the change of the Society's Herbarium and Library Rooms at the College, was read:—

28 HERIOT ROW, *12th March* 1863.

Dear Sir,—I regret that an unavoidable engagement will prevent me from being at the meeting of the Botanical Society this evening, and I have therefore to request that you will bring before the Society, at private business, the following statement regarding the accommodation of that portion of the Herbarium which is at present in the University.

Since my appointment to the Chair of Medical Jurisprudence there has been found the greatest difficulty in providing me with the apartments necessary for the business of my class.

After much fruitless search, it was found that no other place was available except the rooms occupied by the Botanical Society. It was, at the same time, found no less difficult to discover a place in the College to which the Society could be transferred, and the Senatus accordingly agreed to grant a sum of money to take a room somewhere out of the College for the Society, but when I came to make the necessary inquiries it was found impossible to get suitable rooms at a reasonable rent in a convenient locality.

At this juncture Mr. Cameron, the University Janitor, placed at the disposal of the Senatus a room forming part of his house, sufficiently large to hold the Herbarium presses, and to allow of the work of distribution of specimens, etc., being carried on.

The difficulties which had to be surmounted in this matter, and which I need not detail, left so little time for altering the rooms before the commencement of my lectures, that it was necessary to take prompt action in regard to the Botanical Society's effects. After consultation, therefore, with Professor Balfour, it was agreed to accept Mr. Cameron's offer, and under sanction of the House Committee of the University, the Society's presses have all been safely moved, and the room, as you know, is now available for the purposes of the Society.

I have to apologise for not having formally brought this before the Society previous to removing the presses, but there was no time to be lost, and I trust to the Society granting me a bill of indemnity for thus acting, on the consideration that it is better that it should be accommodated within than without the University.

The benches, etc., belonging to the Society which were in the other room, and not in actual use, are all put aside in a secure place.

Let me remind the Society that they have not a permanent right to rooms in the University; that on receiving six months' previous notice the Society must remove from the University at any May term that the Senatus may desire,[1] and it was only the fact of my not being inducted in time enough, to give this notice, that the Society had not to remove at the ensuing Whitsunday.

It is more than probable that notice will be given in time to make the removal necessary next year.

As this would throw the expense of finding accommodation on the Society, I venture to suggest that we ought

[1] This action of Professor Douglas Maclagan caused a good deal of strong feeling among the members of the Society, who felt aggrieved. It appears that Professor Douglas Maclagan made a mistake, and did himself a great injustice in acting as he did, but he was so popular that the event was soon forgotten. The Senatus of the University should have given the Society six months' notice, which they did not do.

at once to address a strong memorial to the Commissioners for Woods and Forests, urging the importance of adding more accommodation to the present Museum in the Botanic Garden, and thus enabling us to have the whole of our valuable collection in one place.

Have the goodness to lay this before the Society this evening.—And believe me to be yours truly,

DOUGLAS MACLAGAN.

*John Sadler, Esq.*

The meeting appointed Professors Maclagan, Archer, and Balfour a Committee to draw up a Memorial to the Commissioners of H.M. Works, urging upon their Lordships the necessity of providing more accommodation at the Royal Botanic Garden for the Herbarium and Library.

At the meeting of the Society held on 9th April 1863, the Minutes of the meeting of 12th March 1863 were read and approved.

The following Memorial to the First Commissioner of H.M. Office of Works asking for more accommodation at the Botanic Garden for the University Herbarium was also adopted at the meeting of 9th April 1863:—

To the Honourable the First Commissioner of Works,

The Memorial of the President and Fellows of the Botanical Society of Edinburgh, humbly showeth—

That the President and Fellows of the Botanical Society were appointed by the Patrons of the University in 1839[1] Joint-Curators of the University Herbarium, along with the Professor of Botany.

That in 1851[2] an arrangement was made with the Office of Works, by which it was agreed that accommodation should be granted for the Herbarium in rooms at the Royal Botanic Garden.

That the collection was thereafter transferred to the Garden, and that it has been ever since accessible to every one who wishes to consult it.

That the accommodation is now totally inadequate for the purpose, and that thus the collection of plants has

[1] Should be 9th January 1839.

[2] No note in Minutes of any such arrangement in 1851 or about that year.

been materially injured and its usefulness impaired for want of room.

That, in consequence of want of accommodation at the Garden, part of the specimens are now deposited in a room in the Janitor's house at the College.

That the cases holding the collection interfere at present with the prosecution of Botany in consequence of diminishing the size of the room in which the students meet for practical work with the microscope.

In these circumstances your Memorialists humbly request that you will authorise steps to be taken for securing additional accommodation at the Garden for this very valuable collection of plants, which is the only public Herbarium in Scotland.

Nothing seems to have come from this Memorial.

The Minutes of the meeting, held at 5 St. Andrew Square, 14th December 1871, were signed by the President, Professor Wyville Thomson, on approval 11th January 1872. These are the first Minutes of the Society that are signed.

At this same meeting a Committee was appointed, of which Dr. Craig was Convener, to examine and report on the present state and position of the Society's Library.

At a meeting of the Council of the Society, held at 5 St. Andrew Square, on 30th January 1872, Dr. Craig reported that he had visited the Society's Library, along with Professor Balfour and Mr. Sadler, and he was of opinion that there were upwards of 1000 volumes in the Library, and that at least one-half of them required to be bound. To put the books in order, make a catalogue, and provide cases for them would, he thought, cost fully £100. He suggested that a Committee might be appointed to ascertain whether Government would be disposed to take the Library under their own charge, and accommodate it in the Herbarium Hall at the Botanic Garden.

After some discussion, it was remitted to Professor Balfour to have an interview with Dr. Lyon Playfair, and Mr. Matheson of H.M. Office of Works, on the matter, before taking any decisive steps.

The Council held a meeting at 5 St. Andrew Square on 5th March 1872, and at that meeting the following Minutes of the meeting of the Library Committee, held at 5 St. Andrew Square, 5th March 1872, were read, which were as follows:—

*Present*—Dr. Craig, Convener; Mr. Buchan, Mr. Evans, and Mr. Sadler.

Dr. Craig stated that Professor Balfour had reported to him that he had had an interview with Mr. Matheson, of H.M. Office of Works, on the subject of handing over the Society's Library to the Government, and Mr. Matheson was of opinion that the Society should make an offer of the Library, in the first instance, to Professor Balfour, as Regius Keeper of the Royal Botanic Garden, and he to bring the matter under the notice of Government.

This the Committee agreed to recommend to the Council.

After some remarks from the Chairman (Professor Wyville Thomson) and Professor Balfour, the Council decided to bring the recommendation of the Library Committee before the next general meeting of the Society.

The matter was brought up at the meeting of the Society, held at 5 St. Andrew Square, on 14th March 1872.

It was moved by Dr. Anderson Henry, and seconded by Mr. Buchan, that the consideration of the recommendation of the Council as to the Society's Library be delayed till the April meeting, when it would be disposed of. A notice to this effect to be put on the April billet.

The Council of the Society met at 5 St. Andrew Square, 30th April 1872.

The following letter, drawn up by the Library Committee in accordance with instructions received at last general meeting, was read and authorised to be transmitted to Professor Balfour. The letter referred to read as follows:—

BOTANICAL SOCIETY'S ROOMS, 5 ST. ANDREW SQUARE,
EDINBURGH, *23rd April* 1872.

To Professor Balfour,
Regius Keeper of the Royal Botanic Garden.

Sir,—We are authorised by the Botanical Society of Edinburgh to offer, through you, the Library of the Society to H.M. Board of Works, for the purpose of forming a

nucleus of a consulting library for the Herbarium in the Royal Botanic Garden of Edinburgh.

The Library consists of about 1000 volumes, and many of the books are valuable and useful for Herbarium work. You are aware that the Herbarium at the Garden is open to the public, as well as to the members of the Society, and many of them consult it. There has, however, been long felt a want of books to consult in the examination of plants.

The Society are aware that you, as Regius Keeper of the Garden, have endeavoured to remedy this defect by granting visitors the use of books from your own private library.

The Society believe that no public collection of dried specimens of plants can be available for scientific purposes without a consulting library.

They therefore wish for the sake of the public, and for the advancement of Botanical Science, to do what they can to supply the deficiency.

The Society will hand over to the Government the entire Library, and continue to send any botanical works which they may from time to time receive, on the understanding that the Government will provide for their accommodation and keeping, and that they will be open for consultation to the members of the Botanical Society, as well as to the public who may wish to consult the Herbarium.

The Society have desired us to send this communication to you, with the request that you will forward it to head-quarters, with such a statement as you may think necessary to make. The Society believe that by this offer they are conferring a great favour on the public—that they are enhancing the value of the Herbarium at the Garden—as well as contributing in no small degree to the promotion of Botanical Science, and are thus endeavouring to secure for Scotland what England already possesses in the valuable Government Library at Kew.

We enclose an extract from the Minutes of the Botanical Society, authorising us to make this offer.

Signed in the name and by the authority of the Library Committee.

William Craig, M.D., C.M.,
Chairman of Library Committee.

At the meeting of the Society held in the Classroom, Royal Botanic Garden, 9th May 1872, it was reported by Professor J. H. Balfour that he had transmitted the letter from the Society to Government regarding the handing over of the Library to Mr. Ayrton, of H.M. Treasury, through Dr. Lyon Playfair, and that Dr. Playfair was to take the first opportunity of forwarding it.

The following is a copy of the letter sent by Professor J. H. Balfour to the Right Hon. A. J. Ayrton:—

ROYAL BOTANIC GARDEN,
EDINBURGH, 16*th May* 1872.

Dear Sir,—As Regius Keeper of the Edinburgh Botanic Garden, I have received the enclosed letter from the Botanical Society of Edinburgh, and now confirm it, with the request contained in it. I now forward it to you by the Hon. Commissioners of H.M. Works. At the same time I take the liberty of urging strongly the propriety of accepting the generous offer of the Society. I have long been asking for means of providing a consulting library in connection with the Herbarium in the Garden, and it is with great pleasure that I now transmit the Society's offer.

The Library contains many valuable books, which will be most serviceable to those who consult the Herbarium. I have long felt that the usefulness of the collection was much impaired by the want of books.

I hope, therefore, that I shall be authorised to receive the gifts on the part of the Government, and that I may ask a letter to allow *uniting the books in the Herbarium Rooms.*

I am satisfied as to the value of the Library, and I venture . . . [1] to you the propriety of accepting it.—Your obedient Servant, J. H. B.

At a meeting of the Council of the Botanical Society, held at 5 St. Andrew Square, Edinburgh, 5th June 1872, Professor Balfour read a letter from Mr. Ayrton, of H.M. Treasury, which had been addressed to Dr. Lyon

[1] A few words in this letter cannot be read, possibly the words omitted are "*to suggest.*"

Playfair in answer to the letter transmitted by the Society through Dr. Playfair to Government regarding the handing over of the Library. Mr. Ayrton says: "It seems very desirable to carry through the proposal, and I will urge it on the Treasury as soon as I have had the estimate made of the expenses."

At a meeting of the Council of the Botanical Society, held at 5 St. Andrew Square, Edinburgh, 2nd July 1872, Professor J. H. Balfour stated that Mr. Matheson, of H.M. Board of Works, had visited the Botanic Garden according to instructions received from Mr. Ayrton, and had made an estimate as to the probable expense of providing room and cases for the Library. Mr. Matheson's report would be submitted to Government.

At a meeting of the Council of the Society, held at 5 St. Andrew Square, Edinburgh, 5th November 1872, Professor J. H. Balfour reported the building for the accommodation of the Society's Library was now in progress.

The Society met at 5 St. Andrew Square, Edinburgh, on 14th November 1872, and the following letter from Mr. Matheson, of H.M. Office of Works, to Professor Balfour was read:—

H.M. Office of Works,
Edinburgh, *30th September* 1872.

Dear Sir,—With reference to my communication with you regarding accommodation for the Library of the Botanical Society offered to the public, I have to state that the Lords Commissioners of H.M. Treasury having sanctioned the expenditure necessary for the accommoda-tion for the books, etc., I have been directed by the First Commissioner of H.M. Works, etc., to proceed with the erection of an apartment adjoining the Herbarium of the Royal Botanic Garden and supply the necessary cases and shelving.—I am, dear Sir, yours faithfully,

Robt. Matheson.

At a meeting of the Botanical Society, held 14th December 1876, Professor J. H. Balfour submitted a circular letter he was issuing regarding the Botanical Society of Edinburgh having presented their collection of

books to the Government—"These, with additions since received, are now arranged in a room connected with the Herbarium at the Royal Botanic Garden."

*Note.*—Donations to the Herbarium from all sources used to be reported to the Society, and minuted in a general way. This should still be done, as the Society are curators.

*Important.* — At a meeting of the Council of the Botanical Society, held 5th February 1884, Mr. Andrew Taylor, the Assistant-Secretary, intimated that he had received, as Secretary, an additional £1 stg., making in all £2 this session, from Dr. Peter White, Yetholm, for duplicate British plants from the Herbarium, and asked instructions as to the disposal of the money.

A Committee, consisting of Professor Dickson, Messrs. Neill Fraser, and Taylor, as Convener, was appointed to report as to the Society's right of property in its duplicate plant specimens for distribution, in connection with the gift of its general Herbarium to the University.

The Committee reported at a meeting of the Council of the Society, held 3rd March 1884, as follows:—

"The Committee beg to report that the specimens in question are in a very confused condition as regards labels, etc.; that it is ten years since the Society last received money on account of duplicate specimens; and that, considering all the circumstances of the case, it is expedient that the Society relinquish any claim of property it may have in its duplicates in favour of the University Herbarium; and that the £2 in question be paid over to the Herbarium Fund."

The Council agreed to recommend the Society to adopt this report.

The Society at its meeting, held at 5 St. Andrew Square, on 13th March 1834, agreed to the disposal of the duplicate specimens at the Herbarium as recommended by the Council.

At a meeting of the Council, held 4th November 1884, a Committee was nominated to approach the Government with the view of getting them to purchase all or part of the library of the late Isaac Anderson Henry, Esq., for the Government Library at the Royal Botanic Garden.

The Committee was appointed at the meeting of the Society held 13th November 1884.

At a meeting of the Council, held 2nd December 1884, "Mr. Taylor made a report, as requested at last meeting of the Society, as to the terms on which the Society gifted their collection of books to the Government Library at the Royal Botanic Garden. In this report the letter offering the books to Government was quoted (ex Minute of Library Committee, 23rd April 1872, and adopted as an instrument of the Society on 30th April 1872)—this letter given in full, page 11.

"Considerable discussion followed the giving of this report, especially regarding the manner, and by whom, the presents of books which the Society from time to time received should be acknowledged and handed over to Government. Ultimately the matter was left over to a subsequent meeting of Council."

At the meeting of the Council held 2nd February 1885, "The consideration of the form of acknowledgment for books received by the Society was referred to a Committee composed of Prof. Dickson, Mr. Taylor, and the Assistant-Secretary (Dr. J. M. Macfarlane), with power to draw up a suitable form for the approval of the Council."

At a meeting of the Council of the Society, held at 5 St. Andrew Square, 1st April 1890, "Prof. Balfour stated that he was glad to inform the Council that a *Curatorship of the Herbarium and Library had been established by Government*, and that the salary of £130, rising by increments to £200, had been voted for the purpose as an annual grant."

At a meeting of the Council, held at 5 St. Andrew Square, on 30th December 1890, Mr. Lindsay, President, in the chair,

A letter was read from Prof. J. B. Balfour, suggesting that the Society publish its Proceedings monthly. In that letter, Prof. Balfour refers to the close relationship between the Royal Botanic Garden and the Botanical Society, as follows:—

"I do not need to point out the intimate connection that there has always been between the Society and the Garden, and everyone would, I am sure, deprecate any step

that might in the smallest degree produce a tendency to separation. The Garden has benefited by the Society, the Society has benefited by the Garden, and procedure that led to separate publication of results of work done in the Garden would unquestionably tend to injure the Society, and in so doing would injure the Garden itself.

"The publications of the Society go a long way to bringing of exchange books to the Garden Library, and it is therefore clearly on that ground alone, if on no other, the interest of those charged with the maintenance of the Garden to keep a jealous watch over the publications of the Society, to endeavour to support these, and to make them as valuable as possible. It would be suicidal in present circumstances to bring out a Garden Bulletin which would be practically a rival of the publications of the Society."

I feel sure that our members will generally agree with the sentiments of Professor J. B. Balfour as expressed in the foregoing letter.

*Her Late Majesty Queen Victoria becomes Patron of the Society.*

At a meeting of the Society, held at the Royal Botanic Garden, on 14th June 1838, "The Secretary stated that a letter had been received by Dr. Graham (letter in Dr. Balfour's possession) from Wm. Gibson-Craig, Esq., M.P., enclosing a communication from Lord John Russell, intimating that Her Majesty had been graciously pleased to become Patron of the Botanical Society.

At the meeting of the Society held in the Royal Institution, on 14th February 1839, there was exhibited an impression of the Society's Diploma on white satin for presentation to Her Majesty the Queen.

Address to the Queen upon Her Majesty's marriage to Prince Albert, read at meeting of the Botanical Society, 13th February 1840.

At the meeting of the Society held on 12th March 1840, it was proposed that Professor Graham be requested to bring under the notice of H.R.H. Prince Albert the desire of the Botanical Society to elect him a British Honorary Member.

At a meeting of the Committee of Management of the Society, held on 14th May 1840, a letter from the Private Secretary of H.R.H. Prince Albert was read, stating that the Prince would have much pleasure in seeing his name enrolled amongst the Honorary Members of the Botanical Society. The Prince was duly elected by acclamation.

Letters of congratulation was sent by the Botanical Society to Her Majesty on the birth of the Princess Royal, afterwards Dowager Empress of Germany; and again on the birth of the Prince of Wales, now His Majesty King Edward VII.

At a meeting of the Society, held at 6 York Place, on 9th January 1862, a letter of condolence to Her Majesty Queen Victoria on the death of H.R.H. Prince Albert, the Prince Consort.

Sir George Grey acknowledged receipt of this letter through his Secretary, on 14th January 1862.

*Prince of Wales.*

At a meeting held on 12th March 1863, Professors Maclagan, Archer, and Balfour were appointed a Committee to prepare and transmit a congratulatory address to H.R.H. the Prince of Wales.

At the meeting of the Society held on 9th April 1863, on the motion of the President (Professor Douglas Maclagan), and carried by acclamation, H.R.H. the Prince of Wales was elected an Honorary British Fellow of the Society.

A congratulatory address upon the occasion of his marriage with Princess Alexandra of Denmark was ordered to be transmitted to His Royal Highness through the proper quarter.

At a meeting of the Botanical Society, held at the Royal Botanic Garden on 14th May 1863, a copy of the Society's Diploma, coloured by Dr. Greville, with leather case mounted with silver, for presentation to H.R.H. the Prince of Wales, were subjected to the meeting.

On the 11th June 1863, a letter was submitted to the meeting at the Royal Botanic Garden from Lieut.-General Knollys, conveying the thanks of H.R.H. the Prince of Wales for his election as a member of the Society, and also for the Diploma sent him.

IN 1901, ON HIS ACCESSION TO THE THRONE AS KING EDWARD VII., HIS MAJESTY GRACIOUSLY BECAME PATRON OF THE SOCIETY.

At the meeting held at 5 St. Andrew Square, on 12th November 1863, on the motion of the President, Professor Douglas Maclagan, H.R.H. Prince Alfred was elected by acclamation a British Honorary Fellow of the Society. Professor Maclagan, President; Professor Balfour, Vice-President; and Dr. Greville, Secretary, were appointed a Committee to prepare and present the Society's Diploma to the Prince.

On 10th December 1863, a letter was submitted to the meeting from Major Cowell, conveying the thanks of H.R.H. Prince Alfred to the Society for his election as an Honorary Member.

Professor Balfour also intimated that the deputation appointed at last meeting had waited upon His Royal Highness at Holyrood Palace, and presented it to him.

His Royal Highness attended a special meeting of the Botanical Society, held in the Royal Society's Rooms, Mound, Edinburgh, 24th March 1864, and inscribed his name on the roll of members.

At the meeting of the Society held at the Royal Botanic Garden, on 14th May 1868, on the motion of Professor J. H. Balfour, a loyal address was voted to the Queen expressing the Society's gratification at the deliverance of H.R.H. the Duke of Edinburgh from the hand of the assassin, and also one to the Duke to a similar effect.

At the meeting held on 11th June 1868, the Secretary laid on the table a letter from the Secretary of State (Gathorne Hardy) in reply to the loyal address which the Society had forwarded to Her Majesty the Queen, and which she had been graciously pleased to accept.

At the meeting of the Society held on 9th July 1868, the Secretary laid on the table a letter from Colonel Augustus Liddell in reply to the address sent to H.R.H. the Duke of Edinburgh, stating His Royal Highness had been graciously pleased to accept it.

Resolved at meeting of Society held at 5 St. Andrew Square, 12th February 1874, "To send an address of

congratulation to H.R.H. the Duke of Edinburgh on the occasion of his marriage to H.I.H. the Grand Duchess Marie Alexandrovna of Russia."

The draft of the address was approved at a meeting held at 5 St. Andrew Square, 9th April 1874, and the Secretary authorised to forward it.

A letter of thanks, written by command of his Royal Highness, and dated from Clarence House, St. James', S.W., 13th April 1874, was duly received by the President and Fellows of the Botanical Society.

A letter of condolence, agreed to at the January meeting, to be sent to Her Majesty Queen Victoria on the death of the Princess Alice, was read at the meeting of the Society held at 5 St. Andrew Square on 4th February 1879, and the President and Hon. Secretary were authorised to sign it on behalf of the Society, and forward it to the Home Secretary for presentation.

Letter of thanks received, dated 18th February 1879, and submitted to the Society at their meeting, 13th March 1879.

At a meeting held at the Royal Botanic Garden on 9th June 1887, it was resolved to send an address from the Society to Her Majesty Queen Victoria congratulating her upon her Jubilee.

An acknowledgment was duly received from the Marquis of Lothian through his Secretary, dated 29th June 1887, stating that the address had been duly forwarded for presentation to Her Majesty.

The Secretary of State wrote from Whitehall, 19th July 1887, stating that Her Majesty had received the address "very graciously."

The Society met at 5 St. Andrew Square on 14th January 1892, and after the private business adjourned, owing to the death of H.R.H. the Duke of Clarence.

At a meeting of the Council of the Botanical Society, held at 5 St. Andrew Square on 5th February 1901, it was remitted to the President and Colonel Bailey to draw up an address to be presented to the King on the occasion of his succession to the throne.

On the motion of Dr. William Craig, it was agreed that the forthcoming billet be printed on white paper with

a mourning margin, out of respect to the memory of the late Patron of the Society, Her Majesty Queen Victoria.

At the meeting of the Botanical Society held at 5 St. Andrew Square 14th February 1901, the address of condolence with the King was read and adopted.

*Other Royal Personages who are, or have been, Members of the Botanical Society.*

His Majesty the King of Saxony, elected 10th January 1839 a Foreign Honorary Member.

His Majesty Frederick William III., King of Prussia, elected a Foreign Honorary Member 11th April 1839.

His Majesty King Oscar II. of Sweden, elected a Royal Honorary Fellow 10th January 1878. Letter of thanks sent by direction of the King, per his Minister in London, read at the meeting of the Society 14th March 1878.

In addition to the above, His Late Imperial Majesty the Emperor of Brazil was an Honorary Fellow of the Society, who joined in December 1874.

## APPENDIX.

### CURATOR.

Mr. James M'Nab appointed first Curator 17th March 1836. Resigned at meeting 10th November 1836, but was prevailed upon to continue in office as Joint-Curator.

8th December 1836.—At meeting held at the College, Mr. Stewart appointed Joint-Curator along with Mr. M'Nab.

10th December 1840.—At a meeting of the Committee of Management of the Society, it was proposed to elect, in addition to the other Office-bearers, a Curator of the Library, as it was increasing so fast. The Council resolved to postpone consideration.

At a meeting held on 13th May 1841, Mr. Brand gave notice of a motion—"That it is inexpedient *that any extra Academical Teacher of Botany should in future hold the office of Curator of the Society's Herbarium and Library.*"

At the meeting of the Society held at the Royal Botanic Garden 10th June 1841, the above motion was moved by Mr. Brand, seconded by Mr. Campbell, and carried unanimously.

Considering the altered circumstances, and the invaluable services rendered to the Society by extra Academical Teachers of Botany, the Society might well consider the advisability of having the above motion rescinded.

At a meeting of the Society, held 14th April 1842, a Memorial and

Petition to Government for aid in defraying the salary of a Curator was read and approved. Mr. Brand intends to present this when in London.

On the 12th May 1842, at the usual meeting of the Society, Mr. Brand reported, on the part of the Committee of Management, as to his proceedings in London with respect to obtaining an annual grant for the salary of a Curator for the Society's Museum.

From the third Annual Report by the Botanical Society, on the state and progress of the University Herbarium and the Botanical Library connected with it, there was evidently a want of funds, and an acting and salaried Assistant-Curator could not be appointed. This was at the end of 1843, but at the meeting held on 11th July 1844 it was reported by the Council that they had obtained the services of Mr. Evans as Assistant-Curator for two years, commencing on 15th May 1844, at a salary of £30 per annum.

8th March 1849.—Mr. George Lawson, Edinburgh, appointed Assistant-Curator; the salary to be £35 per annum, if, after investigation, it was found that the Society could afford that sum or more.

There were many well-known members of the Society who held the office of Curator, but in December 1862 an Honorary Curatorship was begun, and the Professor of Botany appointed to the office, and the post seems to have been held by the succeeding Professors of Botany in the University until 1901. Professor J. B. Balfour having resigned in 1901, the Society appointed Mr. Wm. Caldwell Crawford, F.R.S.E., their Curator.

## RULES.

The original Rules agreed to are not entered in Minutes.

Rules altered 14th December 1837.—"The Office-bearers of the Society shall consist of a President, four Vice-Presidents, six Councillors, one British and two Foreign Secretaries, a Treasurer, and a *Curator who shall be elected annually* by means of signed lists."

## ROOMS FOR MEETINGS.

The meeting of the Society 10th November 1836 was held in the Classroom of Professor Graham, at the College, at 7.30 p.m. Prof. Graham stated that, until more suitable accommodation could be obtained, he would make the Society welcome to the use of his Classroom.

The Society having arranged to rent a Meeting Room at the Royal Institution from the Scottish Society of Antiquarians, held their first meeting there, on 8th November 1836.

At a meeting of the Society, held 11th April 1839, the Secretary stated that Dr. Traill had given the Society the use of a room in the College, adjoining that in which the Herbarium is kept, to be employed as a Library and Consulting Room.

The Society met in various rooms during subsequent years, and, among other places, at 6 York Place. The Society first met at 5 St. Andrew Square, on 13th November 1862.

## TEA AFTER MEETINGS.

Proposed at meeting held at Royal Institution 10th January 1839. At the meeting held on 14th March 1839 it was arranged that tea should be provided at the meeting to be held on 11th April 1839, and has since been continued at the evening meetings.

## EXTENSION OF THE ROYAL BOTANIC GARDEN.

On the suggestion of Professor J. H. Balfour, at a meeting of the Council on 3rd November 1874, it was remitted to the Secretary and President to bring up the desirability of the Society addressing a Memorial to the Government at the next ordinary meeting of the Society.

At the meeting held on 12th November 1874, it was remitted to the President and the Honorary Secretary to draw up a Memorial in favour of the extension of the Royal Botanic Garden, the Memorial to be signed by the President in the name of the Society, and transmitted to H.M. Government.

The reply of the Government, through H.M. Office of Works, is dated 22nd January 1875. They declined to purchase part of the lands of Inverleith for an extension of the Botanic Garden, but said that, if either the city of Edinburgh or the University purchased the land and handed it over to the Office of Works, they would ask Parliament to vote the additional yearly cost of maintenance.

The arrangements to purchase the Arboretum were completed between the Government and the Town Council of Edinburgh about May 1877.

## LOCAL PENNY POST ABOLISHED.

At a meeting, held in the Royal Institution, of the Committee of Management of the Botanical Society, on 9th January 1840, it was ordered that, "In consequence of the change in the local penny post delivery in and around Edinburgh of the Billets intimating the Society's meetings, etc., these should in future be delivered by a person, at as moderate a charge as could be arranged, say, 2s. 6d. a meeting."

# HEPATICÆ OF BEN LAWERS DISTRICT.

By SYMERS M. MACVICAR.

(Read 10th April 1902.)

I spent five weeks within the years 1900 and 1901 at Kiltyrie, near the base of Ben Lawers, with the object of becoming familiar with the Hepaticæ of the district. Several botanists have searched these hills for hepatics, but none have apparently devoted the whole of their time to this subject, judging from the number of additions to our flora, some being not very rare, which I was enabled to make. The localities searched by me were the range of hills from Ben Lawers to Creag-na-Caillich, and the low ground from Lawers to Killin. June was the month chosen as, the ground being still moist, most of rare fruiting species are then in best condition.

Ben Lawers lies almost exactly in the centre of Scotland, and its hepatic flora combines both the eastern and the

western types, but the former greatly preponderates. Only about one-fourth part of our Atlantic species occur, and then are mostly in small quantity. I include *Lejeunea patens* with these, but I cannot consider it as a species distinct from *L. serpyllifolia.* The small typical plant which is confined, or almost so, to the west side of the country, where it is common, is distinct enough, but when it extends eastwards, and even in some of its forms on the west coast, one frequently meets with plants which, in my opinion, are indistinguishable from the small form of *L. serpyllifolia.* None of its characters are constant, either separately or when looked at as a whole; the size of stipule and postical lobe, the shape and direction of antical lobe, as well as its size and amount of chlorophyll, the manner in which it diverges from the postical lobe, the crenulation and height of wings of the perianth, and the intricate branching of the stems—are all characters which can be matched in some forms of *L. serpyllifolia.* In the same manner, the characters which separate the small form of *L. serpyllifolia* from the large form can be seen in many intermediate forms, but in the case of *L. patens*, we have a plant to a considerable extent constant in its form within a certain geographical area, and I think it is thus entitled to sub-specific or, at least, varietal rank. *Saccogyna viticulosa* is the most noticeable of the Atlantic species of the district; it is confined here, as elsewhere when occurring in the centre of Scotland, to shaded ravines, and is not seen on exposed rocky banks, as is frequently the case on the west coast.

Few alpine species are to be found below 2500 ft., except on Creag-an-Lochan, where moist shaded rocks descend to 1800 ft. From 2500 to 2800 ft. on most of the hills, and to about 3300 ft. on Ben Lawers, most of the rare species occur which affect wet ground, as the side of rills and marshy places. Above this to the summits, the ground is mostly bare humus, which is the favourite site for several of the rarer plants, such as the small species of *Acolea* and *Marsupella.* Some species, which are almost confined when on the lower ground to rocks, are to be found on this humus, and in this position generally have longer stems and grow in larger patches. On the east side of

Ben Lawers, the bare humus descends considerably lower, and as the snow remains for a longer period here than on the other parts of the hill, the small species will be found in good condition on the moist soil after they have become scorched on the south and west sides. Botanists who know only the localities on Ben Lawers for the rarer flowering plants will be disappointed if they search these places for hepatics. Here, as in many other places, it will be found that the poorest localities for phanerogams, and frequently for mosses, are the richest for hepatics, the presence of the latter being, with a few exceptions, almost entirely a question of moisture.

There appears to be more limestone among the schists of Creag-an-Lochan than on the other hills, judging from the abundance there of some of the species, such as *Jungermania Muelleri* and *Metzgeria pubescens*, which prefer this soil.

I have to express my thanks for assistance with critical plants to Mr. W. H. Pearson, Herrn Kaalaas and Stephani, and Prof. V. Schiffner.

Plants new to the flora of the British Isles are marked †. I have included all the species from the neighbourhood of which I have seen specimens.

*Frullania Tamarisci* (L.)—Common on the low ground; also common on rocks on the hills, ascending to 3200 ft. *F. fragilifolia*, Tayl.—Frequent on the low ground; rare on the hills, ascending to Creag-na-Caillich, 2600 ft.; on Ben Lawers, 2700 ft. *F. dilatata* (L.)—Common on the low ground; very rare on the hills, and only seen once, at Creag-an-Lochan, 2000 ft.

*Lejeunea serpyllifolia* (Dicks.)—Common in ravines; frequent on the hills, ascending to 3300 ft. *L. patens*, Lindb.—Rare; Finlarig Burn ravine as an intermediate form between this plant and var. *cavifolia*, Lindb., of *L. serpyllifolia*. *L. calcarea*, Lib.—Very rare; on *Thamnium*, Finlarig Burn; on rocks, Creag-an-Lochan, 1800 ft.; Cam Chreag, 2700 ft.

*Radula Lindbergii*, Gottsche—Frequent on the hills, ascending to 3900 ft., usually with sterile female flowers. *R. complanata* (L.)—Common on the low ground; noticed at Creag-an-Lochan, 2000 ft.

*Porella lævigata* (Schrad.)—Frequent in Finlarig Wood; very rare on the hills, Creag-an-Lochan, 1800 ft. *P. platyphylla* (L.)—Confined to the low ground, where it is rather common. *P. rivularis* (Nees)—Common on the low ground; rare on the hills, ascending to 3200 ft.

*Pleurozia cochleariformis* (Weiss.)—I did not meet with this species, but I have seen a specimen gathered on Ben Lawers by Greville, 1822. Mr. W. Young sent me a specimen from Glen Lochay, where he mentions that it is locally frequent.

*Anthelia julacea* (L.)—Very common on the hills to 4000 ft. I saw a plant on the shore of Loch Tay, with *Saxifraga stellaris*, doubtless carried down by a stream. *A. Juratzkana* (Limpr.)—Frequent on the higher parts of the hills, and apparently common on Ben Lawers from 2800 to 4000 ft. The lowest specimen examined was from Creag-an-Lochan, at 1900 ft.; fruit common.

*Herberta adunca* (Dicks.)—Rather common on the hills to 2900 ft. On the summit of Creag-na-Caillich, a small black form occurs with spreading leaves, which would hardly be recognised with the naked eye as this species. On the exposed parts of the hills, the plant is dark-coloured, leaves not furcate, and with shorter points. It has, however, only a superficial resemblance to *H. Sauteriana* of the Continent.

*Blephariozia ciliaris* (L.)—Frequent, ascending to 4000 ft. *B. pulcherrima* (Hoffm.)—Rare; on fir trees, Finlarig Wood.

*Trichocolea tomentella* (Ehrh.)—Frequent in Finlarig Burn ravine.

*Blepharostoma trichophyllum* (L.)—One of the commonest species, ascending to 4000 ft.

*Lepidozia reptans* (L.)—Frequent on the low ground. *L. setacea* (Web.)—Rare, except on the peat moss above Meiller, Ben Lawers, at 2500 ft.; Meal Gheaordie, W. Young.

*Bazzania trilobata* (L.)—Rare; at foot of tree, Finlarig Wood. *B. triangularis* (Schleich.)—Very common in many forms, ascending to 4000 ft.

*Kantia trichomanis* (L.)—Common, on stumps and banks on the low ground; ascends to 3000 ft. on Ben Lawers.

*K. Sprengelii* (Mart.)—Common on banks in Finlarig Burn ravine; Kiltyrie; Lawers Den; near Lochan-na-Lairige, at 1500 ft.

*Cephalozia bicuspidata* (L.)—Common; noticed to 2900 ft. *C. curvifolia* (Dicks.)—Common on decaying logs in Finlarig Wood; Ardmore Wood. † *C. pleniceps* (Aust.), Lindb.—Confirmed by W. H. Pearson.—Creag-an-Lochan, on bank at south end of precipice (c. per.), June 1900; on two places above the landslip, on moist rocky banks (c. fr.), 2000 ft., June 1901. In two of the localities it is accompanied with *C. bicuspidata* (L.), but is readily distinguished from it in the field by its larger leaves, which more resemble *C. lunulæfolia* in shape, but are also larger than that species. *C. fluitans* (Nees)—Among *Pleurozia*, Glen Lochay, 1896, W. Young. *C. denudata* (Nees)—A green alpine form, Ben Heasgarnich, 1900, P. Ewing. *C. divaricata* (Sm.)—Common on logs and stumps on the low ground; rather rare on the hills, ascending to 3900 ft. *C. leucantha*, Spruce.—In marshy ground, close to Lochan-na-Lairige, at 1550 ft.

*Pleuroclada albescens* (Hook.)—Ben Lawers (c. per.), 3400 ft., on moist humus below a snow patch.

*Hygrobiella laxifolia* (Hook.)—Common on the sides of streams both on the low ground and on the hills, ascending to 3400 ft.; perianths frequently present, and fruit not rare.

*Eremonotus myriocarpus* (Carr), Lindb. & Kaalaas.—On wet rocks, rare; Ben Lawers, 3100 ft. (c. per.), 3900 ft.; Cam Chreag; Creag-an-Lochan, in plenty on one series of rocks, at about 2000 ft.

*Scapania resupinata* (Dum.)—Rare, only seen on the low ground; Ardmore; Finlarig Wood, on boulders. *S. subalpina* (Nees)—Common in gravelly detritus at side of Finlarig Burn in the ravine; frequent on the hills, in moist detritus; very rarely on rocks; ascends to 3300 ft. *S. æquiloba* (Schwægr.)—Rare; on rock ledges on the hills, among erect moss tufts, Creag-an-Lochan, 2300 ft.; Cam Creag ♂, 2700 ft.; Ben Lawers ♂, 3000 ft., 3200 ft. *S. aspera*, Müll. & Bern. — Finlarig Wood, 1900, P. Ewing. † *S. crassiretis*, Bryhn.—Ben Heasgarnich, on a wet rock, 3200 ft., July 1900, P. Ewing. Notes on this

species will be found in "Journ. Bot.," 1901, p. 210. *S. undulata* (L.) — Common to 3300 ft. *S. purpurascens*, (Hook.)—Common to about the same height as the preceding. *S. intermedia*, Husn.—Rare; on a log, Finlarig Burn. *S. irrigua* (Nees)—Rather common in marshy places to 1800 ft.; rather rare on the hills to 3200 ft., where it usually occurs on moist rock ledges among other species and mosses. *S. uliginosa* (Swartz.) — Rare; ascends to 3200 ft. *S. rosacea* (Corda.)—Rare; but occurs on all the hills to 2800 ft., on soil, not on rocks; perianths common. This species never seems to be with us in any quantity; it is very difficult to get a good specimen. *S. curta* (Mart.)—On a turf wall (c. per.) with *Diplophyllum albicans*, Kiltyrie. *S. umbrosa* (Schrad.)—Rather common on logs in Finlarig Wood; Kiltyrie.

*Diplophyllum albicans* (L.)—Very common to 4000 ft. *D. taxifolium* (Wahlenb.)—Only seen in two localities on Ben Lawers, on a bank at 2800 ft. (c. per.), and at 3000 ft. *D. Dicksoni* (Hook.)—Rare; on boulders, Creag-an-Lochan (c. per.), 1900 ft.; Ben Lawers, 3000 ft.

*Lophocolea bidentata* (L.)—Common on the low ground. *L. cuspidata*, Limpr.—Finlarig Burn ravine. *L. heterophylla* (Schrad.)—Rare; only one specimen seen near Kiltyrie, among tree roots.

*Chiloscyphus polyanthos* (L.)—This species does not appear to be common in the district; it is rare on the hills, ascending to 2800 ft.

*Harpanthus Flotowianus*, Nees—Rare; in several places at the side of streams on the east side of Ben Lawers, from 2600–3200 ft.; on the south side to 3000 ft.; Creag-an-Lochan, 2000 ft. This rare species generally is found at the edge of the streams with the undulate forms of *Pellia*, which are common in such places, and with *Nardia obovata*.

*Mylia Taylori* (Hook.)—Rare; peat moss, Lochan-na-Lairige; frequent in a limited locality among wet rocks near Lochan Chait, from 2600–2700 ft. *M. anomala* (Hook.)—Less rare than the preceding; peat moss, Lochan-na-Lairige; Meiller bog, about 1800 ft.

*Plagiochila asplenioides* (L.)—Very common; ascending to 4000 ft.; the larger form (*major*, Nees) is common in Finlarig Burn ravine. *P. spinulosa* (Dicks.)—Rather com-

mon in Finlarig Burn ravine, otherwise rare; very rare on the hills, but occurs in a few places on Creag-an-Lochan, 1700–1900 ft.

*Jungermania cordifolia*, Hook.—Common in springs and sides of streams on Ben Lawers, from 2500–3300 ft.; frequent on Cam Chreag and Creag-an-Lochan; fruit common, and usually in abundance when present; Finlarig Burn, at 700 ft. and at 1200 ft. *J. pumila*, With.—Very common on wet rocks at the side of Finlarig Burn in the ravine; Kiltyrie; Creag-an-Lochan, on wet rocks, at 1800 ft. *J. atrovirens*, Schleich. in *Dum. Syll.*; confirmed by Herrn Kaalaas and Stephani.—In quantity on wet rocks, Creag-an-Lochan, 1800–2000 ft.; Ben Lawers, 3200 ft.; Cam Chreag, 2700 ft.; Creag-na-Caillich, 2600 ft. I cannot satisfy myself as to the position of this plant. In its dioicous inflorescence and flagelliform stems it agrees with *J. riparia*, but it differs much from that species, as I have seen it from rocks on the low ground, where it is of a dirty green colour, and with perianths which are pyriform and deeply plicate. *J. riparia*, however, occurs also in stoney marshy ground on the hills, and in these positions it is occasionally dark green in colour, and the perianth sometimes oblong-ovate. *J. atrovirens* agrees with *J. pumila* in its colour, shape of leaf, and to a large extent in its perianths, for although the perianth of *J. pumila* is typically fusiform and hardly plicate, it is not unfrequently oblong-ovate and plicate to the middle. Flagellæ are also sometimes present on the stem, but not as a rule, and are very few when they do occur. The difference in the inflorescence is important, *J. pumila* being paroicous. The perianths of these plants being examined when they are at the same stage of growth, when it is mature, but before the egress of the capsule, it will be found that even under those conditions there is a considerable variation to be seen. On the whole, I am inclined to regard *J. atrovirens* as an alpine variety of *J. riparia*. *J. riparia*, Tayl.—Rather common in wet places, both on the low ground and on the hills, ascending to 3200 ft. *J. sphærocarpa*, Hook.—Rare; near the exposed summit of Creag-na-Caillich, at 2900 ft., as typical *J. lurida*, Dum.; on more sheltered ground, at 2700 ft.,

it occurs as an intermediate form between this and typical *sphærocarpa*. I did not see this species on the low ground. *J. crenulata*, Sm.—Uncommon; Kiltyrie (c. per.), on old turf wall; Creag-an-Lochan, in quantity (c. fr.) among moist gravel, 1800 ft., with marginal cells not well marked. Var. *gracillima*, Sm.—On banks on the low ground, Kiltyrie, Killin, Ardmore. *J. autumnalis*, DC. (*J. subapicalis*, Nees) —Very rare; on a rock in Finlarig Wood near the road, and close to the footpath leading to Creag-na-Caillich (c. per.). *J. inflata*, Huds.—Not a common plant in the district; Meiller Bog, in quantity, fruit very scarce; in marshy ground, Ben Lawers, 2700 ft.; also occurs on dry rocks on Creag-an-Lochan, at about 1900 ft., as a small black form, which has the appearance of a *Marsupella*. *J. bantriensis*, Hook.—Rare; Finlarig Burn, on a wet bank; side of stream at Lochan-na-Lairige; Ben Lawers, from 2700–3000 ft. Var. *Muelleri* (Nees)—Rather common on the low ground among wet rocks; very common on the hills, ascending to 3400 ft., frequently with perianths, but very rare in fruit. Although the small form of grassy rock ledges is very different from *J. bantriensis*, there are many forms among wet rocks which are very difficult to separate from it. †*J. heterocolpos*, Thed.; confirmed by Herr Kaalaas.—On a rock ledge, Creag-an-Lochan, at 1700 ft., with *Bryum pallens* and *Mnium marginatum*. This species is easily distinguished from any other of the *Muelleri* group by the leaves at the apex of the stem being deformed by gemmæ. *J. barbata*, Schmid.—Uncommon; on grassy ledges at Creag-an-Lochan; a stipulate form on Ben Lawers, 2600 ft., and on Creag-na-Caillich, 2700 ft. *J. lycopodioides*, Wallr.—Rather rare; ascending to 4000 ft., and descending to 1800 ft. on Creag-an-Lochan. *J. Flœrkii*, Web. & Mohr.—Common from 1800–4000 ft., especially on grassy banks of streams. †*J. quadriloba*, Lindb.—On several places on the hills on wet grassy ground by the side of streams and rocks; Ben Lawers, south and west sides, from 2600–3000 ft.; Creag-an-Lochan, 1900 ft. and 2100 ft.; Creag-na-Caillich, 2800 ft. The Perthshire plant is more frequently three-lobed than four-lobed. A distinct species, its nearest allies being *J. Flœrkii* and *J. Kunzeana*. In Lindb. and Arn., "Musci

Asiæ Borealis," p. 37, the characters will be found which distinguish it from these species. It is with *J. Flœrkii* that it is most likely to be confused in Britain, but can be distinguished in the field from it by the nearly transverse leaves, strongly gibbose sinus, margin of lobes markedly reflexed, with the point incurved. †*J. polita*, Nees—Ben Lawers; in several localities on wet ground, usually by the side of streams, as at 2700 ft. in two places above Lochan Chait; on the south side at the side of stream, at 3000 ft.; on the west side, at 2700 ft. and at 3100 ft. In two localities mixed with *Harpanthus Flotowianus*; the other species mixed with it being *Scapania undulata*, *S. rosacea* (?), *J. bantriensis*, *Nardia obovata*, and *Aneura pinguis*. The male plant appears to be frequent. I have since found this very interesting addition to our flora on Ben Vorlich, Loch Lomond, on a bank near a waterfall, at 1900 ft. *J. Kunzeana*, Hüb.—Rare; wet ground, usually at side of streams, Ben Lawers; above Lochan Chait, 2700 ft.; south side, 2900 ft.; and in the Ordinance ravine, 3900 ft. *J. Helleriana*, Nees—On decaying fir stumps in Finlarig Wood, in some quantity. *J. minuta*, Crantz.—Only seen in one locality, Ben Lawers, east side, 3300 ft. *J. saxicola*, Schrad.—Very rare; on a boulder at Creag-an-Lochan, 1800 ft. *J. orcadensis*, Hook. —Occurs on all the hills, but is not common; ascends to 3200 ft.; male plant, at 3200 ft., on Ben Lawers; also in Glenlochy, gathered by W. Young.

*Nardia hyalina* (Lyell.)—Uncommon (?); side of Morenish Burn (c. per.); not noted on the hills. *N. obovata* (Nees) —Common at the side of streams on the low ground, and on the hills to 3200 ft.; fruit common. †*N. subelliptica*, Lindb. — Confirmed by Herr Kaalaas; on rock ledges, Creag-an-Lochan, 1800–3000 ft. (c. fr.); Ben Lawers, 3000 ft. (c. fr.). I am inclined to consider this as an alpine variety of *N. obovata*; the rootlets have sometimes a purplish tinge, the leaves and bracts are not always distinguishable from *N. obovata*, and the free portion of the uppermost bracts are occasionally squarrose. In its typical state, however, it is readily distinguishable from the small *N. obovata* of rocks on the low ground. Barren forms, growing among *Jungermania atrovirens*, are difficult to dis-

tinguish from that plant. *N. compressa* (Hook.)—Submerged in a small loch, Creag Mhor, Glenlochy; P. Ewing, July 1898. A form with the leaves markedly squarrose. *N. scalaris* (Schrad.)—Common everywhere to 4000 ft. *N. silvrettæ* (Gottsche)—A small alpine form on Creag-na-Caillich, 2500 ft.

*Marsupella emarginata* (Ehrh.)—Common on the hills; ascending to 3200 ft. *M. Funckii* (Web. & Mohr.)—On a disused road, Kiltyrie; on gravelly soil, Bein Ghlas, 1000 ft.; Ben Lawers, 1300 ft. This species has been reported as occurring on the hills, but I failed to find it there. Fruit is fairly common on the west coast, but I did not see it in Perthshire. *M. ustulata*, Spruce.—Creag-an-Lochan, 2000 ft., on rocks; Ben Lawers, in a few places, from 2700–3900 ft., on gravelly soil; fruit common. †*M. condensata* (Angstr.), Kaalaas *non* Lindb.—In abundance on bare moist humus on the east side of Ben Lawers, at 3200 ft. Determined by Herr Kaalaas. This interesting addition to our flora forms a brown carpet on parts of the hill where little else grows, except *Conostomum boreale.* The shallow lunate sinus, without a hyaline border to the leaf, is characteristic, but the specimens were so luxuriant that I thought it could not be this species. Herr Kaalaas, however, mentions that he has seen similar large specimens from a few places in Norway. It is a high alpine species, confined to North Europe and the Austrian Alps. It is considered by Herr Kaalaas to be the same plant as *M. æmula* (Limpr.), with which opinion Prof. V. Schiffner agrees. A full account of the species, with excellent figures, will be found in Kaalaas's "Beiträge zur Lebermoosflora Norwegens," 1898.

*Acolea crassifolia* (Carr.)—Ben Lawers, 3900 ft. In quantity, on gravelly soil, near a snow patch (c. fr.). This species has been previously found in the district by C. J. Wild and G. Davies. *A. varians* (Lindb.) (*Sarcoscyphus confertus*, Limpr.).—Frequent in many parts of Ben Lawers, from 2800 ft. to at least 3400 ft., forming large patches on gravelly soil, and fruiting freely. This plant bears a close resemblance to *A. crassifolia*, and I find much difficulty in distinguishing them in the field. It has previously only been gathered on Ben Nevis as a few scattered stems, which

Mr. Pearson, in his "Hepaticæ of the British Isles," mentions as being, in his opinion, different from *A. varians*, but I think that the fine specimens from Ben Lawers show it to be the same plant. *A. corallioides* (Nees)—Rather common on boulders in the western corrie of Ben Lawers, from 2800–3200 ft. Fruit seen only in one place. Uncommon on the east side of the hill. *A. concinnata* (Lightf.)—Common on the higher parts of Ben Lawers, from 2800–4000 ft., generally on earthy or gravelly soil; on earthy soil, at 1300 ft. Frequently in fruit. Occurs also on the other hills, but is not as common as the following:—*A. obtusa* (Lindb).—Common on boulders and rocks on Ben Lawers, frequent on the other hills; fruit frequent.

*Saccogyna viticulosa* (Mich.)—Rather common in Finlarig Burn ravine.

*Fossombronia Dumortieri*, Lindb.—On the sandy shore of Loch Tay, at Ardmore, in some quantity, in hollows in which there is decayed vegetable matter. This locality was shown to me by Mr. W. Young, from whom I had previously received specimens with spores. Mr. P. Ewing also sent me specimens, gathered by him in 1883, which he informs me were distributed under another name. It is an interesting addition to the flora of Scotland. This is the commonest species of the genus in Scandinavia, and should be looked for in other parts of Scotland on damp sandy heaths.

*Pallavicinia Blyttii* (Mœrck.)—Ben Lawers, in several places, on small peaty banks on grassy slopes, from 3100–3400 ft. The bracts of the female flowers, which were present in all my gatherings, at once distinguished this species from *Pellia*. The frond is also more lobed than in *Pellia*, and the colour different; when fresh, it bears a good deal of resemblance in colour to *Salix herbacea*, which occurs on the same kind of ground; fruit not seen.

*Blasia pusilla*, L.—Common in wet gravelly places on the low ground, Finlarig Burn, etc.; only seen on the hills at Creag-an-Lochan, 1900 ft., on moist gravelly soil, and Meiller Bog, at about 1800 ft.

*Pellia epiphylla* (L.)—Common on the low ground, and on the hills to about 2700 ft., ascends to 3000 ft.; but not identified with certainty above this. *P. Neesiana* (Gottsche),

Limpr.—Frequent on the low ground and on the hills; above 2700 ft. it becomes commoner than the preceding, and ascends to 3300 ft. At the sides of small rills, on the high ground, an undulate form of *Pellia* is abundant, which belongs to both species, but mostly to the latter, as far as I found, from the specimens examined, which had inflorescence; in the barren state they cannot be distinguished with certainty. *P. calycina* probably occurs on the low ground, but I did not see any specimens which I could distinguish with certainty.

*Aneura palmata* (Hedw.)—On logs in Finlarig Wood. *A. ambrosioides* (Nees), Pears.—Common among wet rocks in Finlarig Burn ravine; frequent in marshes, ascending to 2700 ft. *A. pinguis* (L.)—Common on wet ground to 3300 ft.; fr., 3000–3200 ft.

*Metzgeria pubescens* (Schrank.)—Very common on Creag-an-Lochan, on rock ledges; frequent on Ben Lawers to 4000 ft.; not seen on the low ground. *M. hamata*, Lindb.—Rather common in Finlarig Burn ravine, rare otherwise; Creag-an-Lochan, 1800 ft. *M. conjugata*, Lindb.—Common in Finlarig Burn ravine; occasionally on the hills, noted to 2600 ft. *M. furcata* (L.)—This does not appear to be as common as the preceding species, but sufficient material was not brought home to give its distribution with any exactitude. The two last plants require to be in good condition to be distinguished from each other unless inflorescence be present.

*Marchantia polymorpha* (L.)—Seen only in one locality. Ben Lawers, on moist ground, beneath boulders, in the west corrie, at 3200 ft. (c. fr.).

*Conocephalus conicus* (L.)—Common on the low ground, rare on the hills; Creag-an-Lochan, 1800 ft.; above Lochan Chait, 2700 ft.; Ben Lawers, 3200 ft., with the preceding.

*Reboulia hemisphærica* (L.)—Rare; on limestone wall by roadside between Killin and Kiltyrie.

*Preissia commutata* (Lindenb.)—Common on the low ground, frequent on the hills, ascending to 3300 ft.; fruit common. The plant on the high ground has smaller and narrower fronds than the low ground plant has, but I was unable to find any constant difference in the fruiting parts.

*Riccia glauca*, L.—Mr. Young gave me fresh specimens from the top of a wall at Finlarig. *R. bifurca*, Hoffm.—On moist gravelly soil in some quantity, Creag-an-Lochan, 1800–2000 ft.

## THE BOTANICAL USE OF MUSGROVE'S XYLOL BLUE.

By R. A. ROBERTSON, M.A., B.Sc., F.R.S.E.

(Read 10th April 1902.)

This is what one might call a *multum in parvo* fluid, inasmuch as it removes paraffin, stains and clears at one operation. In an appended note, Professor Musgrove has kindly given the formula, method of preparation, and original purpose of the fluid.

For making a rapid examination of samples of a ribbon during the process of sectioning, the advantages of this fluid are obvious. While primarily intended for such temporary work it can be used for making more permanent preparations, and in this connection either for hand-cut or for paraffin sections, for staining *en bloc* or on the slide.

For general botanical work dilute solutions are recommended, such as, one part of stock (*see infra*) to four, six or more parts of xylol. The addition of a small quantity of glacial acetic acid—one or two per cent.—to the xylol is also advantageous in some cases. The fluid should then be filtered before use.

For *en bloc* staining, the tissue, thoroughly dehydrated is immersed for several hours in the dilute fluid. The time is regulated according to the stainability of the material and the strength of the solution; thus many fungi require at least a night in the one to four solution. It is then transferred to xylol and passed through xylol paraffin into paraffin.

For *on the slide* staining, the slide with the sections affixed is left in the stain from a few minutes to several hours, the time being regulated as in *en bloc* work. They are then mounted in xylol balsam direct or after a preliminary rinse in xylol.

*Hand-cut* sections receive similar treatment; first dehydrate in absolute alcohol, stain, rinse in xylol, and

mount in xylol balsam. For rapid work, or in the case of material very difficult to stain, the stock, or the 25 per cent. solution, may be used; the staining being then carefully watched, and stopped when just right.

The dilute solutions give very satisfactory preparations of fungi, massive algæ, liverworts, and lichens. (Sections of *Sphærobolus*, *Peziza*, *Marchantia*, and *Fucus* were exhibited.)

The cell-membranes of some fungi are particularly well stained, and in the case of fungal spores a selective action is observed, some spores staining well, others not at all, and the same differences are got with spores of the same fungus at different ages. In liverworts, again, the walls of the rhizoids stain very deeply, those of the thallus cells less so.

The best results were obtained with material fixed in absolute alcohol, or in Bliss' fluid followed by absolute alcohol. After Mann's fluid, corrosive sublimate, or picric acid solutions, the results so far are not so good, but this point, which is somewhat unexpected, requires further investigation.

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At the request of Mr. Robertson, I take the opportunity of adding to his communication to the Botanical Society a description of the way in which the xylol blue stain was prepared. It should be mentioned that the purpose for which the stain was originally made was to provide a rapid method of making a preliminary examination of embryo-sections cut in paraffin. The use of the stain for specimens to be permanently mounted is due to Mr. Robertson, and not to myself.

After numerous experiments with various dyes and reagents, I found that by the following method a liquid could be made which, at one and the same time, dissolved the paraffin and stained and clarified the section. The formula for the solution is as follows:—

| | |
|---|---|
| Sodium hydrate . . | 1 grain. |
| Toluidin blue . . . | 6 grains. |
| Absolute alcohol . . | 18 minims. |
| Xylol . . . . . | 600 minims. |

It is important to follow exactly the instructions, and to use only pure ingredients, and special care must be taken to prevent the sodium hydrate becoming moist by contact with the fingers or undue exposure to the air.

Into a *perfectly dry* and stoppered bottle of at least 200 c.c., put first the sodium hydrate. Add next the xylol, and shake two or three times, and then add the toluidin blue. Again shake briskly. At this stage the liquid will appear blue, but the dye is merely in suspension; but, on adding the alcohol and shaking for a few minutes, the colour will change to claret. The liquid should be shaken occasionally during the next twenty-four hours, and then filtered ready for use. In most cases it will be found better to dilute it again with three times its bulk of xylol, as the stain is too dark. The use of a more dilute solution is referred to in Mr. Robertson's paper.

It is not advisable to make a large amount of the stain at one time, as, by exposure to light, precipitation occurs, and the liquid becomes colourless.

J. MUSGROVE, M.D., F.R.C.S.

THE ORIGIN OF THE BRITISH FLORA. By J. G. GOODCHILD, of the Geological Survey, F.G.S., F.Z.S., Custodian of the Collections of Scottish Geology and Mineralogy in the Edinburgh Museum of Science and Art.

(Read 8th May 1902.)

There are very few botanists of the modern school who have not devoted some thought to the origin of the particular flora to which their attention happens to have been turned; and in thinking over some of the anomalies in plant-distribution, they can hardly have failed to make more or less inquiry into the ancestral history of the plants in question. If we are to get a satisfactory answer to any such inquiries, it has long been recognised that it can only be obtained by searching Nature's Records of the Past. These plainly enough inform us that the existing species of plants have descended from a line of ancestors who have survived through a long series of geographical, climatal,

and other changes; and who have gradually been expatriated, have dwelt for many generations amongst strangers in far-off lands, and who have left descendants which have, in their turn, slowly made their way back to the land whence the exodus took place, and then have gradually retaken possession of the ancestral home.

With much of the history thus briefly outlined it is, of course, the special province of the geologist to deal. The question before him, in dealing with such matter, is not What *is* it? but What *was* it? And in searching for answers to that ever-recurring question he often obtains information which proves of interest to his fellow-workers; and in passing it on to his botanical friends he is enabled, to some extent, to repay many obligations under which the help he has got from them has placed him.

It may, perhaps, cause many botanists some little surprise to find that geologists take any interest in biological matters, seeing that it has so long been the fashion, in Edinburgh in particular, for geologists to confine their attention to the lifeless side of geology, and to take far more interest in making out the points of difference between two bits of stone than in deciphering the history of the forms of life which peopled the earth at the time when those stones originated. Tastes differ. My own lead me to regard all geological matters as subordinate to those relating to the Life of the Past. And I am disposed to attach very much greater importance to questions such as those specially under consideration in this paper than to such trivial questions as the difference between a dolerite and a diabase, or that between a basalt and a melaphyre, and so on.

One of the many difficulties that beset a geologist in search of evidence of the kind under consideration is the extremely imperfect nature of the Geological Record. There is only a very small area in the British Isles where we may look, with any reasonable hope of success, for the kind of information we want. In that area, East Anglia, the records are to be obtained only along a narrow strip of seacoast; and, even there, they may be said to be confined to the outcrop of strata which, in the aggregate, are only a few feet in thickness. In these, again, the evidence

consists mainly of the decomposed remains of twigs, leaves, and seeds—most of them too obscure to enable anyone to make out anything of value regarding their botanical position. Still, with patient work, long-continued, much good has been done with such of the material as promised good results. Long lists of plants have thus been recorded, and a vast mass of data has been got together and carefully studied. Then, again, where the evidence afforded by the plant-remains has failed to give the information required, indirect evidence, often of considerable value, has been obtained from a study of the animal-remains associated with the plants.

In considering the subject with this material before one it is necessary to constantly bear in mind the fact that the physical geography of Britain, as we see it to-day, is mostly quite recent in origin. There was a time, for example, and not so long ago either, when Britain stood much higher above the sea than it does now, and when the Forth was entirely a fresh-water river, and the wide space occupied to-day by the North Sea was land, with the Rhine flowing through the lower parts, and making its way to the Atlantic by way of Shetland. This was an event which may well have occurred long after man first peopled these parts. So, too, with the climate. Everyone is familiar with the fact that we have, as it were, only lately been favoured with temperate conditions, which came after a prolonged Age of Snow; and many people are further aware that before that cold period these islands experienced many climatal changes of other kinds. Reflection upon these well-known facts should suffice to convince anyone that our present flora is the net outcome of a complex series of changes of environment in the past.

We may now proceed to consider some of the evidence in support of this view in detail, always bearing in mind in doing so the important principle that the present physical geography of Britain dates back but a short time into the past.

If we go back to consider what the vegetation of the Miocene Period was like, we find traces of a flora quite unlike that which prevails in Western Europe at the

present day; and, as Clement Reid[1] points out, we may at once dismiss that type of vegetation from any further consideration in the present connection. Tracing the course of events onwards, we find evidence that an extensive break exists in Britain between the rocks of Miocene Age and those next newer in the series here: that is to say, we have no record of what plants or animals lived in Britain during the very long period that intervened between the close of the Miocene Period and the commencement of that of Pleiocene Age. So we have, as it were, lost our way there, so far as the ancestral history of the British Flora is concerned.

When we come to the Pleiocene rocks, which are well represented in Britain, we find that the earlier deposits of this age, such as the Coralline Crag and the Red Crag, do not help us much by any direct evidence as regards their flora. But the general nature of their fauna does help, if only in an indirect way, to throw some light upon what was going on in the plant world; for we may safely assume that, if the facies of the animals of one region betoken warm conditions,—or cold, as the case may be,—the plants also must have been those adapted to the same climatal conditions. The Coralline Crag has a distinctly Mediterranean fauna; so we may safely assume that the plants would be, in a general way, of much the same kind as those found in the north-western part of the Mediterranean basin of to-day. It seems as if there existed, in that part of Britain, at least, a sea closed to the north and open to the south-east, and the Mediterranean facies of the fauna is evidently a consequence of those geographical conditions.

The fossils of the succeeding Red Crag seem to show that, with the changes in physical geography that were taking place, a communication was being gradually opened up between this southern sea and the colder waters of the sea to the north. There is no clear evidence to show that any large part of Britain at this time existed as a land area. It is more probable that only a small part did so—perhaps the northern part was land,—but of even this one cannot feel quite sure.

[1] "Origin of the British Flora."

Important, but slow, changes, however, were in progress at each stage, by the operation of which Britain assumed more and more of its present features; but none of these changes have left any direct record of what was taking place in the vegetable world, nor of what species were living on the adjoining area that formed dry land.

Following the Red Crag comes the marine deposit known as the Norwich, or Mammaliferous, Crag. The fossil contents of this tell us of increasing communication with the colder seas of the north, and also of the diversion elsewhere of the warmer currents that had previously reached what is now East Anglia from the south. Furthermore, the remains of large vegetable-eating mammalia occurring in the Norwich Crag speak eloquently of the existence, not far off, of vast woodland areas and extensive pasture lands.

Above the Norwich Crag come in two thin beds containing still larger percentages of boreal mollusca, whose species tell us plainly enough of increasing cold. These rocks are the Chillesford Crag below, and the Weybourne Crag above.

Then follows a thin geological formation, which, in the present connection, is of the very highest importance. This is the well-known "Forest Bed," which, by the way, is not exactly what its name would seem to suggest.[1] It is not an old woodland area submerged, but in reality it is part of the delta of a great river which flowed in the direction of what is now Britain from some continental area to the east. A considerable number of facts point to the river in question having been the ancestor of the present Rhine. The evidence shows plainly enough that the so-called Forest Bed is little else than a deposit formed a long time ago under exactly the same conditions as now obtain in the Norfolk Broads. The difference between the two lies in the fact that the river which gave rise to the old "Broads" came from the east, and not from the west, as is the case with the Broads with which we are familiar at the present day. The essential differences between the

[1] By the way, the word "Forest" simply meant, as its etymology suggests, a place *outside* of the limits of cultivation, without reference to the presence of trees.

two, so far as we are here concerned, are that the plants entombed in the recent Broads date from the present time, and are native to England, while those in the older "Broads" date very far back in time, if we estimate their antiquity by centuries; and, further, they had drifted from the Continent.

Notwithstanding these points of difference, there is an extraordinarily close parallel between their respective floras, as anyone may see by merely glancing over the lists of plants given in Clement Reid's "Geology of Cromer," or those in the Geological Survey Memoir on the "Pleiocene Rocks of Britain." Further reference may be made here to other works by the same author, such as the Annals of Botany, ii. p. 177 (1888), and xii. p. 243 (1898), as well as to his "Origin of the British Flora," Dulau, 1899, the latter being a work that ought to be read with the closest attention by everyone interested in the question with which this paper deals.

Mr. Reid states[1] that "From the Forest Bed fifty-six species of flowering plants have now been determined. Two of them—the Water Chestnut and the Spruce Fir—do not appear to have belonged to our flora since the Glacial Epoch; the others are nearly all still living in Norfolk," and, he adds, "There is also a considerable number of seeds still undetermined, and at least two of these seem to belong to no living British plant.

"The flora contained in the Cromer Forest Bed may be divided into two groups—the forest trees and the marsh or aquatic plants. Of the upland plants, and of the plants of dry or chalky soils, we at present know absolutely nothing. The forest trees are well represented, in fact they are better known than in any of our later deposits. We find the Maple, Sloe, Hawthorn, Cornel, Elm, Birch, Alder, Hornbeam, Hazel, Oak, Beech, Willow, Yew, Pine, and Spruce. This is an assemblage that could not well be found under conditions differing greatly from those now existing in Norfolk. There is an absence of both arctic and south European plants. The variety of trees shows that the climate was mild and moist. The occurrence of the Maple and the Hornbeam shows that the climate can

[1] "Pleiocene Deposits of Britain," p. 185.

have been little, if any, colder than now. The aquatic plants point to the same conclusion, though not so definitely, as many of them are widely dispersed."

Mr. Reid gives lists of the estuarine, land, and freshwater mollusca found in these same beds, and these tell very nearly the same story as do the plant-remains. When, however, we come to study the mammalian-remains, which have been obtained from the Forest Bed in great numbers, both as regards individuals and species, we seem to obtain evidence of a much more important kind, so far as the conditions affecting plant life are concerned. We must, of course, steadily bear in mind the fact that we are dealing with *drifted* remains, and that these probably came from various parts of the Basin of the Rhine, and not from any of Britain. But after making all due allowance for this fact, there is still much that has a most important bearing upon the question here under consideration. We have seen that the plants transported thither were of existing species; and further, as just stated, that the mollusca are mostly recent forms too, a few only being not native to Britain. Among these latter Mr. Reid gives the following:—*Corbicula fluminalis* (which does not live now nearer than the Nile); *Valvata fluviatilis* (Belgium and Germany); *Hydrobia steinii* (Sweden and near Berlin); *H. marginata* (South of France); and *Lithoglyphus fuscus* (Danube). *Limax modioliformis, Pisidium astartoides, Paludina gibba*, and *Nematura runtoniana* also occur.

Amongst the mammals may be mentioned the following:—*Elephas meridionalis* (a gigantic species, even for the genus to which it belongs), *E. antiquus, Myogale moschata, Arvicola intermedius*, and other species. *Trogontherium cuvieri* (a large extinct ally of the Beaver), ten or more species of *Cervus, Rhinoceros etruscus, Equus stenonis* and *E. caballus, Trichechus huxleyi, Machairodus, Ursus spelæus* (the Grizzly Bear), *Canis lupus, C. vulpes, Hyæna crocuta, Gulo luscus, Bison bonasus, Ovibos moschatus, Caprovis savinii Alces latifrons, Hippopotamus amphibius*, and *Sus scrofa*. With these have been found a long list of birds, reptiles, amphibia, and fishes.

The points to notice are—(1) the large size of the mammalia, and especially of the herbivorous species. This,

of course, implies the existence, within the drainage area of the river, of a luxuriant vegetation, and much of it. (2) The number of extinct species. This clearly brings to our notice the fact that mollusca, and also plants, have longer lives as species than have mammalia—a fact of considerable importance in connection with many geological questions. (3) The presence, along with the forms of mammalian life characteristic of temperate regions, of a distinctly sub-tropical fauna.[1] (4) The most important fact of all, that certain distinctly arctic mammals were living within the basin of the Rhine at this period. I would refer especially to such animals as the Glutton and the Musk-Sheep, not to speak of others. Unless we are to assume that the habits of these animals are different now from what they were then, we are driven, it seems to me, to the conclusion that an outward migration from the colder regions of the north was already in progress, and had extended as far south as some of the *northern* parts of the Rhine basin. We have seen that the history of the marine mollusca in still earlier Pleiocene times had foreshadowed this event. What I want to suggest, in referring to these matters, is that, at the time under consideration, rather more snow was falling on Scandinavia than the summer's warmth there sufficed to melt; and that, as time went on, the quantity left each summer, even on the lowlands, gradually became larger. An exodus of the fauna, and, necessarily, also of the flora, therefore gradually set in. Plants slowly retreated to what, for the time being, were to them more congenial habitats; and, as we shall see presently, it was a very long time before they returned.

At this point we may, not unprofitably, turn to the consideration of the age of these events, as measured by ordinary chronological standards. One cannot, of course, be sure of every point in the argument that follows; but still there are some reliable facts to go upon. It is one of the first principles in Geology, and especially when we are dealing with the later Tertiary rocks, that the contemporaneity, or otherwise, of two given sets of rocks

[1] These may have drifted from the warmer *southern* parts of the basin of the Rhine.

which have been found under marine conditions, may be judged of by the percentage of extinct to living species of mollusca occurring in each—the comparison being made with reference, of course, to the species living in the respective adjoining seas. In this way a geologist would say that such or such a deposit in the Mediterranean area is contemporaneous with another such in Britain, because the percentage of extinct species of mollusca, as compared with those now living in the two respective areas, is identical. Measured by this standard, the oldest part of Etna is of about the same age as the Forest Bed. Now, after these strata beneath Etna were laid down, the whole of that vast pile, 10,000 feet in height and 90 miles round, has been built up. Carefully observed data, obtained on Etna, point to that volcano having grown at a rate of about one foot in three hundred years. I should be inclined to set the rate at a much slower one even than that. Taking that, however, as a measure, the date when the Newer Pleiocene rocks there (and here) began to be formed would appear to be not less than three millions of years back in the past. Independent evidence of other kinds, which there is not room to give here, confirms this estimate. Assuming, for the sake of argument, that these figures are approximately correct, we see that the changes which have affected western Europe during the last three million years have sufficed for the extermination of a large number of mammalia, and of some invertebrata also; but these changes, great as they have been in this time, have not sufficed for the extermination of a single plant. This fact is worthy of very special consideration, not only from the point of view of the biologist, but for that of the geologist as well, on account of its bearings upon the question of the Age of the Earth.

Overlying this ancient Forest Bed, and therefore of later date than that deposit, occurs a marine deposit containing *Ostrea*, and an arctic mollusc, *Leda myalis*. This stratum in its turn, is in places succeeded by what is called the Arctic Fresh-water Bed, which contains *Salix polaris*, *Betula nana*, and the remains of the Pouched Marmot—*Spermophilus*.

Then follows a grand display of rocks formed under

glacial conditions, and which are remarkably well seen in the cliffs on either side of Cromer. With these it is not necessary to deal in any detail, because we are only concerned here with the fact that a long and complex series of events followed the close of the period when the Forest Bed was formed, all of which were connected with the fact that an Age of Snow had set in, that it continued here a very long time, and that the area over which the nivosal conditions obtained became larger and larger as time went on.

The essential features of this history which most concern us are, I think,—(1) the long duration of this Age of Snow; (2) the fact that it came on very gradually; (3) that the conditions to which it was due emanated, in the first instance, from Scandinavia; (4) that the "Gulf Stream" was in full operation all the time off the west of Britain and close to Norway; and (5) that the land stood much higher above the sea than it does at present. Many facts incline me to the belief that it was the elevation of the land which gave rise to these nivosal conditions, and it was also that same factor which helped to bring the river-valleys and the coast-line of the British Isles into something like their present form.

The sequence of events, so far as the plants are concerned, was, it seems to me, somewhat as follows:—First, the condensation of the aqueous vapour (derived from the aërial component of the "Gulf Stream") in the form of snow instead of rain, first of all on the mountain summits, and then, as time went on, lower down, and on the lowlands, farther out from the mountain *massifs*. Mountain plants, if they were to hold their own, then had to extend their range outward in the direction of the lowlands. The lowland plants also had uncongenial climatal conditions against them on one side, and they had also the alpine invaders entering into competition with them. So, except on the southern and south-eastern margins of their normal stations, they too were not able to hold their own. Thus, as time went on, they gradually extended their range in the direction away from the margin of the snow, and in the opposite direction they slowly yielded place to the Alpine flora, which was, in turn, also changing ground in the same

direction, as the snow spread still farther outward. Thus, with extreme slowness, and without any violent catastrophe, the temperate Germanic flora spread to more congenial stations; the Scandinavian Alpine flora followed, and the Arctic flora brought up the rear, each extension southward probably keeping pace with the slow advance of the nivosal conditions.

There is evidence to show that the Arctic fauna kept pace with its corresponding flora, and that, in the end, both had extended their range to countries hundreds of miles away from their normal stations.

It is not difficult to understand how other changes that affected plant life were brought about. The piling up of extensive and thick mantles of ice over all the ground from Scandinavia across Britain to the south of Ireland, gave rise to exceptional meteorological conditions, perhaps affecting the isobars very materially, and certainly acting in another way which produced important effects upon plant life. I have held for so many years that the chief cause of the nivosal conditions that prevailed during the Age of Snow were the existence of the "Gulf Stream" close to the 100-fathom line west of Britain and Scandinavia, at a time when the land stood at a much higher level than it does now. One consequence that must have followed from the southward extension of the ice, was that nearly the whole of the aqueous vapour present in the aërial accompaniment of the "Gulf Stream" was either chilled into fog or congealed into snow close to the western margin of the land. The winds passing over the midland and eastern parts of the country were therefore cold, *dry* winds, all the moisture that could be got out of them having already been deposited on meeting with the upland area on the west. These dry winds, therefore, must sooner or later have given rise to *steppe conditions*. That such conditions did exist has clearly been shown by Mr. Reid. We have the remains of many steppe animals entombed in deposits of this age. And if there was a steppe fauna, it appears safe to conclude that there was a steppe flora present as well.

The chronological order of change over any given area, so far as the flora is concerned, seems, then, to be thus—first,

the native flora, each section in its own place; then came the Boreal and Arctic floras, a large part of which must have presented a facies such as would be met with in the Siberian Tundras; next, but only on the south-east margin of the chief area occupied by ice and snow, followed the Steppe flora. It would not be very difficult to mark these belts on a map where these zones of vegetation occurred at the culmination of the Age of Snow—perhaps it has already been done?

The enormous amount of glacial erosion which was accomplished while the North Sea was occupied by land ice[1] proves conclusively, to my mind at least, that the Age of Snow was one of immense length. It may well have taken up the larger part of the time between the Forest Bed period and now. Hence, as the time occupied in these changes of station was so long, and the process of both expatriation and repatriation was so gradual, one need hardly wonder at the small amount of change that has ensued.

To understand what followed after the climax of the Age of Snow was reached, we shall need to adopt some working hypothesis regarding the cause of this remarkable episode:—It is by no means necessary to suppose that the Age of Snow was characterised by a low temperature. All that is needed to account for the facts is to postulate such geographical conditions as should lead to a little—perhaps only a very little—more snow falling on the low-grounds each year than the heat of summer (which may have been considerable, even in Scotland) sufficed to melt. To make the snow, in the first instance, there must have been—(1) copious evaporation going on over the Atlantic; (2) there must have been aërial currents to transport the resulting aqueous vapour in the direction required; and (3) refrigerators, in the shape of snow-covered areas, sufficiently powerful to congeal the aqueous vapour

[1] I have endeavoured in several papers to explain how the Norwegian ice crossed the North Sea. Gravitation was but a subordinate factor. The chief paper is published in the "Royal Physical Society's Proceedings," vol. XIV. p. 137, under the title of "Solar Energy in Relation to Ice."

directly into snow, instead of condensing it into rain, were also essential. If we assume that a belt of land of considerable altitude existed along a zone joining Scandinavia and Britain, and that the so-called "Gulf Stream" and its aërial accompaniment, the vapour-laden winds, were in full operation close to the western margin of the land throughout the whole period, it seems to me that nothing else is required to account for the facts in question. Elevated tracts of land, lying in the path of currents of air heavily charged with moisture, are the chief requisites; and so long as the elevation was maintained above a certain level snow would be precipitated instead of rain, and glaciers and ice-sheets must, from the very nature of the case, have accumulated upon the land.

Now it is thought, by many geologists, that the earth's crust is everywhere more or less in the condition of unstable equilibrium. If natural forces remove much rock, for instance, from a limited area, and then transfer it to an area adjoining, a certain amount of adjustment of the earth's crust must ensue. The land slowly rises, to a small vertical extent at a time, where the load has been eased off; and it slowly sinks, also to a small vertical extent, at the other parts where a load has been put upon it. Now, rain falling upon the land does not remain there, but either flows off or is evaporated, or, more usually, it does both. If snow falls and does not melt, but passes into ice, the load remains, and must accumulate, if thawing does not ensue, or if the ice does not find its way off from the land in the shape of bergs. There is reason to believe that the ice, after a long period near the climax of the Age of Snow, was several thousand feet in thickness in the neighbourhood of the higher mountain masses. Each thousand feet of thickness presses upon the surface beneath it with a weight equivalent to something more than twenty-five tons to the square foot. Hence the aggregate thickness of the glacial envelope, even in the case of North Britain, must have been enormous beyond conception. It has seemed to me for many years back that the effect of so vast an accumulation was to depress the part of Britain where the load was greatest,[1] and perhaps to affect the parts adjoining to a certain extent

[1] As Mr. T. F. Jamieson, of Ellon, was the first to suggest.

as well, even where the ice was thin. The consequences of such a depression were twofold: firstly, the subsidence gradually admitted the sea where there had formerly been land, and thus tended to ameliorate the climate; and, secondly, the depression lowered the mountain tops to an elevation much nearer to the sea-level, where it is warmer than it is at higher elevations. As a consequence, the precipitation began to take the form of rain instead of snow. So the glaciers were cut off at their source, and they quietly and slowly melted away as they stood, leaving the stones and mud with which their lower strata were charged, as a kind of sedimentary deposit, which gradually accumulated between the ice and the underlying rock in the case of the boulder clay; and which, where crevasses existed, gave rise, by the washing of sand and gravel from the surface of the ice into these fissures, to those remarkable deposits of sand and gravel which are generally known as Eskers, or as Kaims, in Scotland.[1]

The sea was admitted up all the old river valleys, such, for example, as the Forth, the Clyde, the Tay, and others in Scotland, as well as in other cases in various other parts of the kingdom. Drowned river valleys, with the tops of the smaller hills standing up as islands, occur not only in the Forth, but all round the British Islands.

It is important for our present purpose to remember that the places which would be the earliest to be disencumbered of their ice and snow, under the depressed conditions, would be the parts most remote from the great mountain masses, and especially those in the southern parts of the kingdom. Next in order to these were the hilltops themselves. Therefore the species of plants earliest to regain a footing would do so in either what were the maritime areas for the time being, or else in the newly exposed alpine region of the uplands.

It seems highly probable (though it by no means follows that it was really the case) that, as the climatal conditions became suitable, and as congenial soils and habitats became

[1] It is but fair to myself to mention here that this explanation of the englacial original of boulder clay, and the formation of Eskers, was first put forward by myself in the "Geological Magazine," for November 1874. Other writers have repeatedly put it forward as *new* since then.

available, the expatriated vegetation gradually returned—the flora proper to the margin of the snow being the first to arrive, and then the other floras, rank behind rank, in reverse order to that which they followed when their exodus took place at the commencement of the Age of Snow. Most of this repatriation probably took place in the southern parts of Britain before the maximum limit of depression was reached, and long before the subsequent movement in the opposite direction commenced.

It is well to bear in mind, in this connection, that there is a large area of shallow sea around the south-western parts of Britain, and that, in the transition period while the depression was still in progress, there was still a land communication across what is now the English Channel, as far as the Pyrenean and Armorican regions beyond. Likewise there was still land communication with the Continent at the southern part of the North Sea.

I see no difficulty whatever, while bearing these facts in mind, in accounting for the extension of Pyrenean and Armorican plants, by way of the land route referred to, as far as Devonshire and Cornwall, or even to the south-west of Ireland. It is mainly a question of time, if the land communication be kept open; and even when the submergence had gone so far as to admit the sea, the earlier stages of that geographical phase were equally suitable for the transport of the seeds by flotation, by the immigration of mammals, and by the transportation effected by birds, etc.

What has long been a cause for wonder with many geologists is, not how it has happened that a few plants have found their way from the Pyrenean areas to Ireland, but why it is that there were not more.

The whole history is one that teems with interest to every student of biology. It is a most remarkable fact, that a whole temperate flora, after long banishment from an area where its place has been held for perhaps hundreds of thousands of years by Tundra and Steppe floras, should have been repatriated without showing any marked evidence of change, and should have almost entirely retaken possession of the land, with only a few of the invaders left to tell of the changes that happened during the term of banishment of the former occupants of the land.

## On the Hepaticæ of Balmoral, Aberdeenshire. By G. Stabler.

(Read 12th June 1902.)

In the year 1884 it was my privilege for about a fortnight in the month of July to be the guest of my friend Mr. J. Michie, His Majesty's present Commissioner on the Balmoral Estate. Similarly in 1894, a little later in the season, for about three weeks, I again visited Balmoral. It was during these two periods that I spent a considerable portion of my time in making collections of *Musci* and *Hepaticæ*.

It is on these gatherings, and on specimens collected by Mr. Michie during the winter and spring preceding my first visit, that this paper is founded. Perhaps I ought to explain that, although I have entitled this paper "On the *Hepaticæ* of Balmoral," I have not shrunk from incorporating in my list a few habitats not strictly within the Balmoral domain.

Permit me to give a brief outline of one of these digressions. Leaving Danzig Shiel, accompanied by Mr. Michie, on the evening of 14th July 1884, we called for a short time at Corriemulzie, and botanised in its lower part. We then drove on as far as the Duke of Fife's shooting-box, near the junction of Glen Lui and Glen Derry, and thence walked to the cottage of the keeper, who gave us a "Highland welcome." In the twilight of the evening we had a stroll on the site of the old Mar Forest, and here on a decaying pine I found beautiful specimens of *Jung. Helleriana*, which had previously been found in April in the Ballochbuie Forest by Mr. Michie, this being, so far as I am aware, its first discovery in Scotland. A little after one o'clock a.m., along with the keeper, we started up the Derry, and reached the head of the glen at daybreak. Not far from the base of a huge precipice of Ben MacDhui, we soon found *Jung. Doniana* and *Scapania ornithopodioides.* We were now on ground made classic by such eminent botanists as Donn, Hooker, Walker-Arnott, Greville, and Gardiner,—to say nothing of others of later date. After lunching on the lee-side of the

cairn on the summit, we commenced our descent to the "shelter stone" at the head of Loch Avon, passing on our way over a large field of snow. Amongst other hepatics were found *Pleurocladа albescens*, *Jamesoniella Carringtoni*, *Jung. saxicola* (the second record for British Isles), and *Marsupella Stableri* (its first record for Scotland). Climbing out, we took the nearest route to the Derry, and thence to Danzig Shiel, which we reached about midnight. Similarly in 1894, another day was spent in going to Glass Maol.

The portion of the county more particularly examined is bounded on the south, roughly speaking, by a line from the summit of Lochnagar, along White Mountain to Loch Phadruig, and on the north from Lion's Face down the river Dee to Balmoral Castle.

In explanation of the long period elapsing between the collection of the specimens and the completion of this paper, I may say that it has been chiefly owing to eye troubles on the part of myself. Most of the specimens were examined and determined long ago, but a few remained for reconsideration. This I was unable to carry out. Through the kind and efficient help of Mr. Symers M. Macvicar, the now eminent Scottish Hepaticologist, the examination has been completed, and I here acknowledge my indebtedness, and thank him not only for this, but for drawing up the list from the specimens, and thus making the publication of it possible.

A glance at Mr. Macvicar's published list of the *Hepaticæ* of West Inverness and at the following list of Balmoral *Hepaticæ* will show considerable differences, although the two localities are in nearly the same latitude. These differences in the main are no doubt attributable to differences of altitude and distance from the sea, and the consequent difference of temperature. There are, no doubt, other less important factors. The only *Plagiochila* I found was *P. asplenioides*. *P. spinuliosa* is reported rare. To me one of the most striking facts was the scarcity of *Lejeuneæ*, only *L. serpyllifolia* being found, and that not plentiful. In this elevated district I found no *Frullania dilatata*, and the genus *Porella* was very poorly represented. The rarely fruiting *Blepharozia ciliaris*

was found here with abundance of colesules and in fruit, often luxuriating on old junipers in the forest.

I ought to have included in my list *Cœsia crassifolia* from Ben MacDhui. The specimen was isolated that its determination might be confirmed by Mr. M. B. Slater, of Malton. He fully endorsed my decision, after careful examination and comparison with other Scotch specimens. It has since been forwarded to Mr. Macvicar.

The following is a list of species collected:—

Frullania Tamarisci (L.), Dum.—Balmoral; Braemar. On decayed birch wood, Balmoral (Mr. Michie).

—— fragilifolia, Tayl.—Balmoral; Glen Beg; Corriemulzie. On decaying trunk of birch, Balmoral (Mr. Michie)

Lejeunea serpyllifolia (Dicks.), Lib.—Balmoral; Glen Beg; Corriemulzie.

Radula complanata (L.), Dum.—Balmoral; Glen Beg (c. fr.); Abergeldie; Corriemulzie. On damp wall, Balmoral (c. fr.) (Mr. Michie).

—— Lindbergii, Gottsche—Glen Beg, 1884.

Porella platyphylla (L.), Lindb.—Balmoral.

Anthelia julacea (L.), Dum.—Ben MacDhui; Lochnagar, Ben Avon, and Lochnagar (Mr. Michie).

Blepharozia ciliaris (L.), Dum.—On dead juniper bush, Balmoral (c. per), August 1894; among Dicranum, Balmoral, 1884; Lochnagar, 1884. On moist rock, Balmoral, 1884 (Mr. Michie).

—— pulcherrima (Hoffm.), Lindb.—On wood, Carn Fiaclan (c. per.), July 1884; on wood, Balmoral, male plant, July 1884.

Trichocolea tomentella (Ehrh.)—Ballochbuie Forest on peaty earth, November 1884 (Mr. J. Michie).

Blepharostoma trichophyllum (L.), Dum.—Balmoral.

Chandonanthus setiformis (Ehrh.), Mitt.—Balmoral, male plant, July 1884; Ballochbuie Forest, with Diplophyllum Dicksoni and Jung. minuta; Glen Beg; Braemar; Lochnagar. On a frequently submerged stone, Balmoral, March 1884 (Mr. Michie).

Lepidozia reptans (L.), Dum.—Feindallacher Burn; Balmoral; Lochnagar. On old bark of trees, Ballochbuie (Mr. Michie).

—— setacea (Web.), Mitt.—Glen Beg, Braemar (c. per), July 1884; Lochnagar. On bare ground, Ballochbuie, and Lochnagar, May 1884 (Mr. Michie).

Bazzania trilobata (L.), Gr. and B.—Balmoral.

—— triangularis (Schleich.), Lindb.—Ben MacDhui; Lochnagar.

—— tricrenata, Wahlend.—Balmoral; Ben MacDhui.

Kantia trichomanis (L.), Gr. and B.—Balmoral; Braemar; Ben MacDhui; Lochnagar. On decayed wood, Balmoral (Mr. Michie).

—— Sprengelii (Mart.)—Ballochbuie Forest, with Cephalozia bicuspidata and Scapania umbrosa.

Cephalozia catenulata, Hüben.—Balmoral, male plant, July 1884.

—— lunulæfolia, Dum.—On decaying wood, Corriemulzie and Ballochbuie Forest; Balmoral (c. per.); Lion's Face, Braemar.

—— bicuspidata (L.), Dum—Ballochbuie; Ben MacDhui. On peaty sand, Balmoral (Mr. Michie).

—— Lammersiana, Hüben.—Ballochbuie Forest.

Cephalozia connivens (Dicks.)—Lochnagar, among Mylia Taylori and Jung. orcadensis, 1884, also among Lepidozia setacea and Jung. orcadensis, 1894.

—— curvifolia (Dicks.), Dum.—On decaying wood, Ballochbuie Forest, with Jung. Helleriana; Abergeldie; Braemar. Ballochbuie (Mr. Michie).

—— Sphagni (Dicks.), Spruce—Glen Beg, Braemar, with Mylia anomala and Lep. setacea.

—— divaricata (Sm.), Dum.—Ballochbuie Forest; Balmoral; Braemar. Ballochbuie (Mr. Michie).

—— leucantha, Spruce—Balmoral, with Lep. reptans and Tetraphis pellucida, August 1894.

Pleuroclada albescens (Hook.), Spruce—Ben MacDhui, below a snow-wreath near Loch Avon, July 1884.

Hygrobiella laxifolia (Hook.), Spruce—Braemar; Lion's Face, 1884.

Scapania compacta (Roth.), Dum.—Glen Beg, Braemar, 1884.

—— resupinata (L.), Dum.—Balmoral; Lion's Face and Glen Beg, Braemar.

—— subalpina, Nees—By the river Dee, Balmoral (c. fr.), July 1884.

—— æquiloba (Schwægr), Dum.—Lion's Face, Braemar, 1884.

—— nemorosa (L.), Dum.—Glen Beg, Braemar.

—— ornithopodioides (Dill. Wither.), Pears.—Ben MacDhui, with Jung. Doniana, 1884.

—— undulata (L.), Dum.—Ben MacDhui; Glen Beg, Braemar; Lochnagar. In a spring near the summit of Lochnagar (Mr. Michie).

—— purpurascens (Hook.), Tayl.—Ben MacDhui; Glen Beg, Braemar.

—— irrigua (Nees), Dum.—Lochnagar, 1894.

—— uliginosa (Swartz), Dum.—Glen Beg, Braemar, 1884.

—— helvetica, Gottsche—Balmoral, 1884.

—— curta (Mart.), Dum.—Balmoral.

—— umbrosa (Schrad.), Dum.—On decaying wood, Ballochbuie Forest; Balmoral. On granite stones and on decaying trunk of Scotch Fir (Mr. Michie).

Diplophyllum albicans (L.), Dum.—Balmoral; Glen Beg, Braemar; Ben MacDhui. On gravelly and sandy soil, Balmoral (Mr. Michie).

—— Dicksoni (Hook.), Dum.—Ballochbuie Forest, with Chandonanthus setiformis and Jung. minuta, 1884; Glen Beg and Lion's Face, Braemar (c. per.), July 1884; Balmoral (c. per.), July 1884, with Jung. minuta; Feindallacher Burn (c. per.), August 1894.

Lophocolea bidentata (L.), Dum.—Lion's Face, Braemar.

—— cuspidata, Limpr.—Lion's Face, Braemar, 1884; Balmoral; Abergeldie.

Chiloscyphus polyanthos (L.), Dum.—Ballochbuie Forest; Glen Muick; Lochnagar.

Harpanthus Flotowii, Nees—Lochnagar. male plant, July 1884 and August 1894; Balmoral, with Kantia trichomanis, 1894.

Mylia Taylori (Hook.), Gr. and B.—Balmoral and Glen Beg, Braemar, male plant, July 1884; Ben MacDhui; Lochnagar.

—— anomala (Hook.), Gr. and B.—Glen Beg, Braemar; Lochnagar.

Plagiochila asplenioides (L.), Dum.—Balmoral (c. per.), July 1884; Lion's Face and Glen Beg, Braemar; Balmoral (Mr. Michie).

Jamesoniella Carringtoni (Balf.), Spruce—Amongst Sphagnum and Jung. Doniana, Ben MacDhui, July 1884.

Jungermania riparia, Tayl.—Ballochbuie Forest, 1884.
—— crenulata, Sm., *var.* gracillima (Sm.)—On old roadway, Balmoral, 1884 (Mr. Michie).
—— inflata, Huds.—On sandy soil, Balmoral, 1884 (Mr. Michie).
—— bantriensis, Hook., *var.* Muelleri, Nees—Braemar, with Aneura pinguis, 1884.
—— bicrenata, Schmid.—By side of river Dee, Ballochbuie, 1884.
—— ventricosa, Dicks.—Balmoral; Ballochbuie, etc.; under the form porphyroleuca would come specimens from Ballochbuie Forest, Balmoral, Glen Beg, Ben MacDhui. On decayed trunk of tree, Ballochbuie (Mr. Michie).
—— alpestris, Schleich.—Ben MacDhui, 1884.
—— gelida, Tayl.—Ben MacDhui, 1884.
—— incisa, Schrad.—Glen Beg, Braemar; Lochnagar. Craig Dalig (Mr. Michie).
—— exsecta, Schmid.—On decaying wood, Ballochbuie Forest, with Scapania umbrosa, 1884; Glen Beg, Braemar, with J. ventricosa; Balmoral.
—— Lyoni, Tayl.—On granite rocks, Balmoral Forest, with J. ventricosa and Chandonanthus setiformis, 1884.
—— gracilis, Schleich.—Among rocks, Braemar, 1884; Glen Beg, Braemar, with J. ventricosa, Chand. setiformis, and Cesia obtusa.
—— lycopodioides, Wallr., *var.* Flœrkii (Web. and Mohr.)—Ballochbuie Forest, with Ceph. divaricata, 1884; Balmoral, with J. minuta, Chand. setiformis, and Diplophyllum Dicksoni; Ben MacDhui; Lochnagar. Balmoral (Mr. Michie).
—— Helleriana, Nees—On decaying wood, with Ceph. curvifolia, Balmoral and Ballochbuie Forests, July 1884; Old Mar Forest, with Ceph. lunulæfolia, July 1884 On decaying wood, Ballochbuie, April 1884 (Mr. Michie).
—— minuta, Crantz.—Balmoral (c. per.), July 1884; Glen Beg, male plant, July 1884; Ballochbuie Forest, with Chand. setiformis and Diplophyllum Dicksoni.
—— saxicola, Schrad.—Ben MacDhui, with Cesia obtusa, 1894.
—— orcadensis, Hook.—Glen Beg, Braemar, 1884; Ben MacDhui, with J. Doniana, 1884; Lochnagar, with Ceph. connivens, Kantia trichomanis, Mylia Taylori, and Bazzania triangularis.
—— Doniana, Hook.—Ben MacDhui, in several places, associated with Bazzania tricrenata, Mylia Taylori, Scapania ornithopodioides, Diplophyllum albicans, and J. orcadensis; male plants, July 1884.
Nardia hyalina (Lyell), Carr.—Glen Beg, Braemar, with Ceph. Lammersiana, 1884; banks of river Dee, Ballochbuie, with Ceph. bicuspidata and Scapania undulata.
—— obovata (Nees), Carr.—Ballochbuie Forest, with Scapania undulata.
—— compressa (Hook.), Gr. and B.—Ben MacDhui, 1884.
—— scalaris (Schrad.) Gr. and B.—Lochnagar. Ballochbuie (Mr. Michie).
Marsupella emarginata (Ehrh.), Dum.—Glen Beg. Ben MacDhu (Mr. Michie).
—— Stableri, Spruce.—Ben MacDhui, July 1884.
Cesia obtusa, Lindb.—Balmoral, 1884; Glen Beg, Braemar; Lochnagar, with Blepharozia ciliaris and Jung. ventricosa. Ballochbuie (Mr. Michie).
—— concinnata (Lightf.), Gr. and B.—Ben MacDhui, with Jung. alpestris, 1884; Glen Beg, Braemar; Lochnagar.

Cesia crenulata (Gottsche)—Glen Beg, Braemar, 1884.

Pallavicinia Blyttia (Mœrck), Lindb.—Lochnagar, with Kantia trichomanis, 1884; also among Cornus suecica, with Ceph. bicuspidata.

Blasia pusilla, L.—By side of river Dee, Ballochbuie.

Pellia epiphylla, L.—On wet soil, Balmoral (Mr. Michie).

Aneura palmata (Hedw.), Dum.—On decaying wood, Balmoral, 1884. On decaying wood, Ballochbuie, 1884 (Mr. Michie).

—— ambrosioides (Nees), Pears.—Lion's Face and Glen Beg, Braemar, 1884; Balmoral.

—— pinguis (L.), Dum.—Braemar.

Metzgeria pubescens (Schrank.)—Lion's Face, Braemar, with Jung. Lyoni, 1884.

—— furcata (L.), Radd.—Balmoral.

—— conjugata, Lindb.—Ben MacDhui.

Marchantia polymorpha, L.—Glen Muick. On carbonised wood, near Balmoral Castle (Mr. Michie).

Preissia commutata (Lindenb.), Nees—The Coyle, Abergeldie; Corriemulzie, 1884.

Specimens of the following additional species from Aberdeenshire have been seen by Mr. Macvicar:—

Frullania dilatata, L.—Dry Den and Den of Rubislaw, 1836 (Prof. Dickie).

Porella rivularis, Nees—Glen Callater, *c. per* (Prof. Dickie).

Pleurozia cochleariformis, Weiss.—Ben MacDhui, 4th August 1830 (Edin. Univ. Herb.).

Jungermania cordifolia, Hook.—Lochnagar (Prof. Dickie).

—— Kunzeana, Hüben.—Amongst Blepharozia ciliaris, Lochnagar, 1887 (P. Ewing).

Marsupella sphacelata, Gies.—Ben MacDhui, 1880 (W. West).

Anthoceros punctatus, L.—On moist bank beside a small rivulet a little north of the Powder Magazine, Aberdeen (Prof. Dickie).

## REPORT ON THE EFFECTS OF A HAILSTORM TO GROWING TIMBER CROPS. By HUGH C. SAMPSON, B.Sc.

(Read 13th March 1902.)

On 12th June 1900, at Holmes Chapel, Cheshire, a very violent thunderstorm, accompanied by hail, occurred, and did a considerable amount of damage both to property and to vegetation generally. This happened at about three o'clock in the afternoon, when we could see and almost feel the approaching storm. The sky became so overcast that it was impossible to read in the house. The rumbling of the thunder gradually became louder, and the flashes of lightning more vivid. The threatening clouds came from the S.E.

The storm burst with a deafening peal of thunder directly overhead, and this was almost immediately followed by the hail. In a few moments the air was full of twigs and leaves which had been cut off the trees. Many of the hailstones which worked this havoc were one and a half inch in their longest diameter, while on an average they measured fully one inch. I have been told, on good authority, that some measured one and three-quarter inch in diameter. The structure of these hailstones was curious. They were all more or less flat in shape, the shorter diameter being about half the length of the longer. One surface was concave and the other was convex. Most of them had an onion-like structure, being composed of successive layers of clear and of opaque ice.

The thunderstorm was quite local, embracing a width of two miles and a length of about ten miles. To give some idea of the force of the storm, I may say that over one thousand square feet of plate glass (21-ounce), representing a quarter of the whole glass area in the greenhouses here, were broken. The opposite side of the valley, however, seemed to catch the force of the storm even more fully. At one place, roofing glass nearly half an inch thick was broken; and I noticed a field of early potatoes, which were nearly ready for raising, completely stripped of their leaves, and with only a few bare haulms left standing. The main roads, which are but slightly sheltered by trees, were strewn so thickly with twigs and leaves that these latter had to be swept up into heaps about four feet in height, and at intervals of about seventy-five yards. Many twigs were left hanging on the trees, which, after a few days, presented quite a withered appearance.

The storm, coming as it did in the middle of June, caught the trees when in their first full leaf. Thus numbers of the still tender twigs were cut clean off, and, owing to the loss of leaves, and the lessening of the feeding area, the year's growth must have been correspondingly reduced.

The wounds caused on the stems of trees were observed only on young bark which was still smooth, and no

damage was seen on the bark of branches more than two inches thick. Coppice-shoots seem to have suffered most, as the bark was necessarily tender, owing to their rapid growth. The wounds on such shoots seem also to have much more difficulty in healing. In all cases, trees with a natural tendency to throw out horizontal branches, and especially when they were grown in the open, seem to have suffered most. The branch had then to encounter the full force of the blow from the hailstones, and thus the newly formed wood was often badly bruised. On the other hand, trees which tended to form vertical branches, and those grown in close woods, seem to have suffered less, as they had not to meet the full force of the blow, and the hailstones glanced off, leaving a comparatively narrow and clean cut which could soon heal. This can be very well seen in the case of the apple trees standing in the gardens here. Standard trees, which are allowed to grow naturally, have not suffered nearly so severely as those grown on the espalier system, with the branches trained horizontally.

## THE AMOUNT OF DAMAGE DONE TO DIFFERENT VARIETIES OF TREES.

Coniferous trees seem to have suffered the least permanent damage; owing to the narrowness of their needles, their foliage practically received no damage, and any wounds formed on the stem were soon covered by the exudation of resin. The wounds may, however, at some future time, impair the quality of the timber of conifers.

Larch appears to have suffered most, owing most likely to the sparseness of its foliage, and to the fact that the needles come off in whorls, and leave the greater part of the stem bare. So far as I have observed, no larch cancer has yet made its entrance by any of these wounds.

Scots pine appears to have been damaged to a considerable extent, though not so badly as the larch. This is most likely due to its heavier foliage, which would more or less protect the stems.

Spruce seems to have suffered the least damage, perhaps because being a shade-bearing tree, its living needles are

carried well up the branches, others protect the branches on which they grow, as well as those lower down.

In regard to broad-leaved trees, they may be named in the following order, commencing with those which were most damaged:—(1) willows and poplars, (2) ash, (3) sycamore, (4) oak, (5) alder, (6) beech, (7) birch. Except in the case of the willows and poplars, which have exceptionally soft bark, the order is the same as that in which these trees would stand if classified according to the thickness of their twigs, those with the thickest twigs being the most damaged.

### THE OCCLUSION OF WOUNDS.

As I mentioned above, the wounds on conifers soon managed to cover themselves by means of the exudation of resin, except in the case of the Douglas fir, on which tree the wounds are still quite open. The rate of occlusion on broad-leaved trees, as far as I have been able to observe, is as follows, commencing with those which healed quickest:—(1) mountain ash, (2) beech, (3) alder, (4) ash, (5) birch, (6) sycamore, (7) oak, (8) poplars and willows.

## Shrub and Tree Planting in Ireland.

By James Whytock, Esq.

(Read 10th July 1902.)

Speaking rather as a professional gardener than as a botanist, I offer this communication on the supposed scientific methods in the past of cultivating trees and shrubs introduced into these Islands from all parts of the world. Forty years ago large landowners all over the kingdom were eager to form pinetums and plant so-called ornamental conifers on their estates, and almost invariably the gardener did this work and not the forester; indeed one may say with confidence that any good collections of recently introduced large conifers throughout the country were planted and tended by gardeners.

For example, at Dropmore a gardener named Frost raised an avenue of Cedars of Lebanon, some Auracarias, and *Abies Douglasi*, so successfully, that the visitor, viewing

these trees at the end of Frost's life, marvelled that they could have been grown in so comparatively short a time. The method practised by the gardener was to keep all soil that had been used in pots, trimmings and road-parings, rotted heaps of leaves, and other garden refuse, to mix these, and throw them periodically on the surface; and as a result of these top-dressings the trees throve.

We may also quote the example of Ochtertyre, near Crieff, where Sir Patrick Murray informed his gardener that his requirements from the garden would be small, and that the gardener might therefore devote his energies to the shrubberies and woods near the mansion.

The result of a number of years' work was one of the best collections of conifers in the kingdom.

My further notes will refer to my twenty-five years' experience in Ireland. In 1873 I had charge of Lord de Vesci's garden and home woods at Abbeyleix, Queen's County. Queen's County at the above date was in the forefront in Ireland as regards arable farming and stock-breeding; the Agricultural Show in the county town, Maryboro', ranked next to the Royal Society's Show in Dublin.

A large tract of bog from which all the turf fit for firing had been cut away was at this time growing a fine wood of Scots pine, forty years planted, all the trees with straight, clean boles, and of an average diameter of fifteen inches. To a neighbouring heath-clad bog seeds of Scots pine had been wafted and a crop of trees resulted, many attaining a good height—these self-sown trees reaching in six years a height and strength equal to what transplants would have required ten years to reach. These unprotected, too, had remained untouched by rabbits and hares, whereas young adjoining plantations of transplants had to be carefully guarded with netting against these animals.

Among trees that did well at Abbeyleix were *Cupressus macrocarpa* and the ordinary plantation trees—larch, spruce, and fir. The evergreen *Magnolia grandiflora*, both grew and flowered well. Rhododendrons, on account of the limey sub-soil, could only be grown by excavating deeply the natural soil and filling in peat soil, of which there was plenty close at hand.

My next experience was in the south part of County Wicklow, where I had the management of the extensive home woods and gardens of Lord Fitzwilliam. This part of the county was colder and later than Queen's Co.; the soil was thin, the cold, shingly sub-soil mixed with a strong clay. The portions of the property where tree planting was carried out ranged from 400 feet to 1100 feet above sea-level. At the 400 feet level was a remnant of the old shillelagh oak forest that once extended to Donnybrook. The oaks still standing were very fine specimens, with long, clean, straight boles, 10 and 12 feet in circumference. It was in this wood only that the true shillelagh sticks were got, a shillelagh being an oak sapling taken up by the root, the root forming the head of the stick.

This large estate, with its high hills, low valleys, varied soils, and varied aspects, gave exceptional facilities for testing the growth of the larch commercially, probably the most valuable timber grown in Britain. One system of planting was adopted over the whole estate, a mixture of larch, Scots pine, fir, silver, common spruce, and some hard woods, chiefly oak, through them. The larch seemed to do equally well on the north side as on the south side of these hills, and grew well on the tops of the highest of them; all the planting was bole planting. A careful investigation was made throughout the whole of the plantations to try and detect any larch disease; the whole estate was pronounced clear of it, excepting two trees, growing with many more larches on a piece of ground, the subsoil of which was blue clay. Deep open drains intersected closely this piece of ground, still, it never became normally dry. Birch grew luxuriantly on this, but I should say larch should never be planted on soils with a cold clay subsoil. I have seen a great deal of high lands in Ireland of little value agriculturally, almost waste, that would grow excellent larch. The Government should plant these otherwise waste mountain tops; they would prove in time a valuable asset to the nation, and, at the same time, improve immensely the value of the surrounding country.

One of the greatest drawbacks to the proper growth of woods and plantations in these islands is the destruction

done by rabbits. Many of the large landowners received 2s. 2d. to 2s. 4d. per pair for rabbits sent to some large centre of Manchester, and the result was that the rabbits were allowed to multiply to such an extent that scarcely a single tree—in woods from thirty to sixty years old—but had its roots a mass of rabbit burrows. The result of the presence of these burrows was the stunting of the tree.

From my experience I am convinced that were rabbits strictly kept out of plantations, the tree crop at the end of forty years would be as good as one at seventy where rabbits were numerous.

There was a long narrow strip of ground which it was desired to convert into a belt-plantation in order to shut out a view of the interior as quickly as possible, and a large area of grass-land had to be planted with clumps of conifers. The land was of a very poor nature—a few inches of soil on the top, all underneath being shingly, with a little clay running through it.

Our mode of procedure was to trench the ground thirty inches deep during the summer, and in the autumn we planted the following trees and shrubs:—*Abies Douglasi*, *A. grandis*, *Nordmaniana*, *magnifica*, *Cupressus Lawsoniana*, and *Thujopsis dolebrata*, these were planted about thirty feet apart; and Scots pine and larch were planted thickly amongst them. In the course of six or seven years the trees grew to ten feet high and more. *A. grandis* grew the quickest, being thirty feet high sixteen years after planting. *A. Douglasi* was the next quickest.

The transplanting of large rhododendrons, and forming them into groups in new places, formed a part of these operations. I transplanted one rhododendron, 20 feet in diameter, a distance of a quarter of a mile, and it grew afterwards with fresh vigour. I found in the transplanting of these large rhododendrons that if we dug out a hole, however large, for each shrub, and planted in that hole, the plants did not grow nearly so well as when a large bed of rhododendrons was made. In making the latter we marked off the size of the clump, threw out the whole earth inside the mark to the depth of two and a half feet, brought our plants, put them in position in this pit, then threw the soil back again into the

pit, mixing with it several cartloads of half-rotten dung and half-rotten leaves. The plants simply rushed into immense growth in this new bed. There were also large clumps of rhododendrons made in gravel areas. The soil being limited to the clump, we top-dressed heavily with cow manure, which produced the finest foliage and splendid clusters of flowers on the best-named varieties of rhododendrons.

We were very successful in planting conifers in pits in a macadamised road for the purpose of concealing a long range of buildings. Some forty trees of *Cupressus Lawsoniana*, nearly 20 feet high, with good balls, were planted in a trench 2 feet deep and 12 feet wide, from which the old road metal had been removed, and fresh soil was then filled in round the roots. This work was done in the autumn, and the following season they grew away and became quite established. These trees now form a fine feature by the side of the carriage drive.

I have treated my subject of tree planting mostly from an ornamental point of view. In expressing practical opinions regarding tree planting there must be a decided distinction made between planting for ornament and planting for utility and profit. The circumstances of our country are such that there is plenty of room for both.

(1) As to utility and profit. — There are many thousands of acres on hillsides, on bog lands, and other places, that can only be called waste land. Patches of these waste lands that have been planted with trees prove that excellent timber can be grown on them; but planting on a large scale is too gigantic a work, and the profits to be realised too long to be waited for, to expect private enterprise to do it as it ought to be done. The Government should, and must eventually, take up this work; and the sooner the better, for until this is done the planting and best cultivation of extensive crops of timber will not be carried out with the capital and the scientific knowledge that work of such national importance demands.

One reason for calling it of national importance is that the climatic condition is ameliorated. High barren lands and large waste tracts destitute of trees are mostly so exposed and arid that neither animal nor vegetable life

can flourish on them; whereas, if they were judiciously planted the climate would be softened, and the barren land would become a moisture-retaining, fertile soil.

This growing of timber would also mean employment and the lessening of rural depopulation.

(2) Planting trees for ornament. — Of the very many trees and shrubs introduced to this country in the last half-century there are probably not more than half a dozen adapted for growing profitable timber; and even these, excepting *Abies Douglasi*, are much too dear to plant extensively. In what better way could some of our wealthy landowners (whose number is ever increasing) spend a portion of their money than in adorning the surroundings of their homes with as great a variety of trees and shrubs as the limit of their grounds allow?

Beauty—something pleasing to the eye—is what is wanted here, and so it is admissible to follow a much higher and more expensive mode of cultivation. If top-dressings of enriched earth, and even good manure, were given much more than they are, we should not so often see the scraggy apologies for ornamental trees we do. Choice of species and varieties should be made to suit the climatic conditions and soil of the locality,—many trees and flowering shrubs grow and flower luxuriantly in the suburbs of London that would not live in the suburbs of Edinburgh.

There exists a generally mistaken idea that the very ornamental *Pinus insignis* is not hardy. This has been proved to be false in some of the coldest districts. I have seen it planted beside the Scots pine, and during a severe blizzard in January the Scots pine was much scorched and injured, while *P. insignis* escaped unhurt.

# TRANSACTIONS AND PROCEEDINGS

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TRANSACTIONS AND PROCEEDINGS

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SESSION LXVII.

## Suggestions towards the Preparation of a Record of the Flora of Scotland. By James W. H. Trail.

(Read 12th February 1903.)

Towards the close of last century it appeared to me desirable to obtain, as far as possible, a record of what was known about the flora of Scotland, to serve in future as a standard of comparison by which to mark changes in the flora, and possibly to show something of the causes on which such changes depend. Much had been done in the previous two decades in exploring districts that had long been unvisited by botanists, and of the results of most of these explorations I had kept notes. It seemed at the outset that little more was required than a careful compilation from the local floras formerly and recently published, and from the numerous lists or fuller articles that had appeared in botanical journals and transactions. But a more careful examination of these showed that we are still far from the accurate information that is necessary before a record can be prepared that could be used as a trustworthy standard for future comparison.

Few of the floras or lists relate to natural areas, and fewer still supply the needful information with desirable completeness. Rarely is there even an attempt to show,

in a systematic way, the distribution of a species within the district included in the flora or list. A few localities are enumerated for many species, and the other parts of the districts are seldom if ever mentioned. Often little more is given than a mere list of names of species, without notes of whether these are natives, or introduced by man, and, if the latter, whether they are casuals or planted or naturalised, weeds of fields or near houses, rare or frequent. Or, if such notes are given, they are so in the most arbitrary way, and often mislead instead of aiding the inquirer. Naturally, the older books and lists are very defective in their treatment of critical groups, whether these relate to polymorphic genera or to forms usually regarded as varieties of polymorphic species.

A good deal of experience in the use of the published records, and also in trying to work out the flora of limited areas in a systematic way, had led me to certain views with regard to the work that is still much required, both in the field and in the preparation of satisfactory records of local floras; and these views may be put forward for criticism.

When the plants of Scotland were first studied, it was scarcely possible to do more than to note the occurrence of species here and there during journeys, and, naturally, more interest was excited by the rarer and more local species than by those common everywhere. It was hardly to be expected that local botanists could be found with knowledge and opportunity to qualify them for an exhaustive study of the districts around their homes. A few localities became known as habitats, either from their vicinity to the larger towns or from exceptional wealth of species. Their reputation led to their being visited by generations of botanists, and all the more local and rarer forms in them were put on record, often many times. But they drew to themselves the attention that would otherwise have been distributed more widely over the country, and, in consequence, many districts remained almost unvisited until a late period, and comparatively few have been really well explored throughout.

Some works on local floras endeavour to give somewhat full information with regard to the plants treated of, *e.g.*

Dr. Buchanan White's "Flora of Perthshire"; but in most of even the larger works, and still more in the briefer ones, we usually find only a few localities enumerated, with the name of the collector or reporter for each, following a brief general statement such as "rare," "frequent," "local," "by streams," "in fields." Man's share in the present state of the flora is very inconsistently treated. Common weeds of cultivated ground are admitted into every list without question, though many of them are dependent on man's labour, not only for their introduction, but also for their continuance in the district. Others are relegated to a special list of species introduced by man, though they may show themselves as widespread as, and better able to retain their hold in the district than, the field-weeds, and along with them are associated many that are clearly mere outcasts and casuals, unlikely to appear in any one locality for more than one or two years unless reinforced. Species are included that have clearly been planted originally where they continue to be found, whether they have spread and become naturalised in aspect, or remain limited to the original spot. Some tree and shrubs are included, *e.g.* the maples and limes, while others are omitted even though they seed freely, *e.g.* the larch, spruce, and silver fir.

The confusion becomes still greater when all species admitted into the local list run on in one series, in which some are noted as "introduced," while to others no such note is added, though not less evidently called for. Man's influence in limiting or extending the numbers and range of distribution of species within a district is even less consistently treated in local lists than his share in their introduction. Remarks on it are usually limited to the few species that have become extinct, or are approaching extinction.

One rarely finds information of a kind at all definite or serviceable with regard to the actual abundance and the relative increase or diminution of the commoner (therefore the usually characteristic) species of a district. Only now and again are terms employed such as imply actual reference to the local conditions. Frequently they might have been copied from some text-book or general flora.

The districts and their local sub-divisions employed in the records of topographical botany in Scotland have varied considerably, and it is not always easy to correlate them so as to make the older ones of use for comparison with the more recent. Yet a good deal is lost if such comparisons cannot be made.

In the earliest works, *e.g.* Sibbald's "Scotia Illustrata" (1684), the topographical information amounts to the notification of the species believed by the author to exist in Scotland, with special localities noted for a few. Lightfoot's "Flora Scotica" (1778), and Hooker's "Flora Scotica" (1821), proceed on almost the same lines. They do not attempt to indicate the local distribution of species in Scotland except by enumeration of localities for the rarer and local forms.

Of the local floras, some of the earlier limit themselves to some distance around a town as a centre, without limitation to, or indication of, special districts, whether natural, such as river basins, or artificial, such as counties and parishes. Of this class are Greville's, Balfour and Sadler's, and Sonntag's floras of the district around Edinburgh, Dickie's "Flora Aberdonensis," and P. Macgillivray's "Flora of Aberdeen." Others, *e.g.* Edmonston's "Shetland Flora," and Hennedy's "Clydesdale Flora," relate to natural areas, but with no systematic sub-division of the areas; and others limit themselves to political districts, such as Johnston's "Botany of the Scottish Borders" and "Flora of Berwick-on-Tweed," Dickie's "Botanist's Guide to the Counties of Aberdeen, Banff, and Kincardine," and Scott Elliott's "Flora of Dumfries, Kirkcudbright, and Wigtown." White's "Flora of Perthshire" is limited to the political area Perthshire and Clackmannan; but that area is chiefly the Tay basin, and is, in so far, natural, and it has been sub-divided in the "Flora" by river basins and geological formations. Thus the two methods are combined in this case.

Mr. H. C. Watson's works on the topographical botany of Great Britain added so greatly to the information available to local botanists, and to the precision and accuracy of that information by his careful analysis of earlier work, that his divisions of counties and vice-

counties have been the basis for very much of the best topographical work of the past half-century. The consistent use of well-recognised divisions has allowed of the results being tabulated, and, by showing where conspicuous gaps in the records existed, it has directed attention to these, and has led to their being filled.

But there are very evident defects in the employment of divisions that are so often quite artificial and of unequal extent, even with the modifications in their boundaries and areas that Mr. Watson employed, and in which he has been followed. Within recent years the boundaries of many counties have been considerably altered, and in some cases the older records have been a good deal altered thereby, and may become misleading. In the valuable handbook of "The Flora and Fauna of the Clyde District," prepared for the meeting of the British Association in Glasgow in 1901, a strictly artificial method was followed, the basis of the river and firth being sub-divided by parallels of latitude and of longitude at each degree and half-degree; and the areas so bounded are denoted by capital letters.

When we seek to gain from books or lists a trustworthy conception of the flora of the district of which each treats, and, still more, if we wish to compare the past condition as recorded for us with the flora as we know it, we find that, in almost every case, much is left untouched that we should greatly like to have a record of. That a plant has been observed in a district is worth noting as a fact in topographical botany, but much more is frequently desirable. If it be a critical species or variety, we should know by whom it was determined, and if a specimen was seen by an expert, and has been preserved as a voucher. If there is no doubt as to accuracy of the determination, there are questions requiring an answer as regards its occurrence, such as the likelihood of its having been introduced by man, its frequency, whether it seems to be extending its range or losing ground, its habitats, etc. But to most such questions an answer is not often found in published records.

The work so successfully begun by Mr. Robert Smith, and the value of which has been well urged by Dr. W.

Smith and by Mr. Hardy, brings prominently into view the chief characteristic features of local floras; but, though it will thus add very greatly to our knowledge of the topographical botany of Scotland, it yet leaves much untouched, and there is ample room for other methods also in attacking the problem. It appears to me that success can be attained only by the co-operation of numerous workers, having a common end in view, but concentrating their efforts on such parts of the problem as leisure and opportunity give them a reasonable hope of advancing. More will be done of permanent value by knowing a limited area thoroughly than by visits to localities noted for their floral wealth, though one's herbarium may not contain so many rarities.

A new factor to be considered in this connection has been introduced by the requirement now imposed on those that are entering the teaching profession, that they shall be qualified to give instruction in nature-study. It may reasonably be expected that among the new teachers some will seek to acquaint themselves with the natural objects of the districts in which they live. Indeed, to become successful teachers of the methods of nature-study they must know what resources are within their reach. Valuable aid may be looked for in a few years from them. But they also require aid; and it would be well that in the preparation of local floras this should be kept in view.

It may be said that as yet I have been speaking chiefly of defects in such topographical records as we have, and that it is not enough to find fault, unless one is prepared to suggest improvements. I must pass on then to the questions of the information that topographical records should supply, and how they can be rendered most useful. In answering these questions we may also find help in determining the form or forms that they should assume.

How much should the record contain? To this some would answer that it should include all plants of the district that clearly do not owe their presence in it to man, and also those introduced by man that now hold their place without his aid or in his fields against his will; but that no others should be mentioned. Watson's

"Topographical Botany" is drawn up nearly within these limits. But even there the limits are not very consistently adhered to.

To me it seems that more accurate results are arrived at if all plants are included except those known in a district *only* in cultivation, and that, even of these, the species commonly cultivated in fields and in gardens, in plantations and in woodlands, might with advantage be named in a separate list. The terms "native" and "indigenous" denote only that the ancestors of the plants now living in any locality arrived in it, so far as we know, without man's aid, by what we call natural agencies; for we have no evidence that any species in the Linnean sense is really indigenous in Britain, though certain varieties and "critical species" (in such genera as *Rubus* and *Hieracium*) are not yet known from elsewhere. Man has profoundly modified the British flora even as regards these "natives," and has admittedly brought into our islands a number of species that are included without question in our lists; while a good many that appear to be "native" in certain districts have in others evidently been introduced by man. The question really becomes narrowed down to the period when they were introduced, intentionally or otherwise, by man; but the *time* of introduction scarcely appears to warrant so absolutely different a treatment as the inclusion of some and the exclusion of others. Man's agency must be recognised as a cause of great changes in the floras of the world. It is in a sense one of the natural forces that modify the vegetation of the world; and the difference between the action of unconscious forces and the conscious agency of man, though great in degree, should scarcely be reckoned as one of kind. Moreover, man's aid in the migration of plants is often as unconscious as any of the natural forces. Is it not desirable to include all, as above suggested, in the local list, and, as far as possible, to ascertain and to record by what agency, and at what period, each has reached Scotland? Records do not exist of a kind such as to permit of our ascertaining whether species may not have been introduced, even within recent times, apart from man's aid.

The past and present distribution of each species should be ascertained in a very much more systematic way than has yet been done, or, except in a few cases, even attempted, the habitats should be indicated, and the frequency should be recorded on some definite scale. Absolute accuracy cannot be expected; but it should be possible to reach a degree such as to permit of the records being used by later workers as a scale by which to determine the changes that show themselves as the years go by, and perhaps to afford evidence of the causes that bring about these changes, both of increase and of decrease or extinction, of gain and of loss. A method that I have made use of to record the changed condition of the vegetation from year to year on made-up ground, and other places near Aberdeen, I have found very useful on limited areas, where a complete record of the species observed was kept, and the rarity or abundance of each was marked by a scale from 1 to 4, denoting rare, common, frequent, abundant, each also modified by the signs − and +. Thus I used twelve grades, from 1 −, denoting extremely rare, to 4 +, denoting abundance to the exclusion of other species. I found it possible in this way to follow with confidence rapid changes in the relative proportions of the species, and also to record the incoming of species new to a locality, and could follow the struggle among the various forms until a relative equilibrium was reached.

For larger areas other methods have been employed. Buchenau, for example, in his "Flora der nordwestdeutschen Tiefebene" (1894), employs signs to distinguish four grades in the relation of plants to the district, viz. * characteristic species; * confined to certain limited habitats, *e.g.* sea-coast, etc.; ↑ species of middle or east Germany that have overpassed the south or east boundary of the north-west German plains; + adventitious plants, relatively late introductions, or immigrants.

It is evident that the usual indications of frequency (frequent, common, rather local, etc.) are defective, as they do not indicate clearly the relative frequency of localities and of individual plants within these localities.

W. Schemmann, in "Beiträge zur Flora der Kreise

Bochum, Dortmund und Hagen" (Verh. d. naturh. Ver. d. Preuss. Rheinlande u. Westfalens, 1884), employs a comparatively simple scale in the form of fractions, the numerators of which denote the number of localities thus—1 in one place, 2 in a few places, 3 in several places, and 4 in many places; while the denominators denote frequency thus—1 sparingly, 2 commonly, 3 in quantities, *e.g.* $\frac{2}{3}$ denotes in a few places in quantities, 5 denotes in countless places in very great amount.

The method I employ for my own notes, after various experiments and rejection of more than one method, is as follows:—

After a general indication of the habitat (*e.g.* sand-dunes, meadows, swamps, etc.), and of whether "native" or "alien," with grade if "alien," I use the Greek letters $\alpha$, $\beta$, $\gamma$, $\delta$, $\epsilon$ to denote the frequency both of localities and of plants within the localities. Thus two simple scales are formed for localities—$\alpha$ denotes in one locality; $\beta$ in two or three in a district, *i.e.* very local; $\gamma$ in a good many, yet local; $\delta$ in many or common; $\epsilon$ everywhere within suitable habitats. Within the localities $\alpha$ denotes only once found; $\beta$ very rare, yet occasionally met with; $\gamma$ not rare, yet not common, to be found without difficulty if looked for; $\delta$ common; $\epsilon$ abundant, even to exclusion of other species in some cases. These scales are combined readily, the first letter denoting localities, the second the individuals within these. Thus—$\alpha\alpha$ denotes in one locality once found; $\alpha\delta$ in one locality, but common there; $\delta\beta$ in many localities, but rare within each; $\epsilon\epsilon$ universally present in suitable habitats, and abundant everywhere.

On theoretical grounds the areas marked out by parallels of latitude and of longitude have the undoubted advantage of simplicity, if denoted in such a way as to combine brevity with freedom from error; but to be really useful the areas must not be large. For noting briefly and accurately the localities of plants in field-work, I use the 1-inch Ordnance maps, divided into areas by the minutes of latitude and the even-numbered minutes of longitude. The spaces so marked off are noted by co-ordinates along the margins of the map, these being capital letters from south to north,

and small letters from east to west. Such a symbol as 77 Br $\boxed{\cdot}$ denotes very closely the locality of some plant gathered on the bank of the Dee a few miles from Aberdeen. The addition of K after the square would show that it grew on the Kincardineshire side of the river. Thus a good deal of writing is saved. The method is also excellently suited to marking out on squared paper the actual distribution of each species in a district.

But if the areas are large (*e.g.* between half-degrees, extending to 900 square minutes) the advantage of precision of reference is lost. They thus are useless alike for notebook and for subsequent mapping, and they are, of course, absolutely useless as indicating natural or well-known political areas.

In this, as in so many other cases, no one method possesses all the advantages, and it is well to combine them, so as in the end to secure all the help that can be obtained.

The geographical method, for publication, is most useful when the distribution is exhibited on maps, so that the eye can appreciate at one view the results expressed in words only at considerable length and in a form difficult to appreciate. With small areas it is, as already said, exceedingly useful in field work. But it is not desirable to ignore natural regions (such as river basins, etc.), though often difficult to define in some respects, and usually themselves in need of sub-divisions based on varied conditions of environment. It is unwise, too, to set aside well-recognised political divisions, for these often appeal most strongly to the local naturalists, and their co-operation is most desirable in working out the distribution of both flora and fauna. Theoretically there is no reason why the investigation of, say, 20 or 25 square miles should not be as heartily entered on as that of a parish, of 140 as of the Cairngorm mountains, or of 2000 as of Aberdeenshire. Yet there is no question that fewer would undertake the one area than the other, though of nearly equal size. It is likely that some of the teachers now being trained will undertake the investigation of the districts around their homes, and to them the parish, or the district, is the area of greatest interest. To local societies the county or

counties immediately adjoining the central town, or some former territorial division (still retained in popular use, though no longer corresponding with existing geographical divisions), or the river basin, is the region to be investigated. To the teachers it is of especial importance to learn what materials for nature-study are within reach, and the books or lists of most use to them are likely to be those that indicate distribution by parishes. But as parishes are seldom natural areas, and as it is desirable that records, whether of field work or when published, should be in form to permit of these latter areas also being recognised, it is necessary to combine the two sets of divisions. I have found that, by making use of the parish boundaries and watersheds of streams, along with local features, such as coast, lochs, lowland, and hill, it becomes possible to obtain areas of a relatively small size, with somewhat uniform characters throughout each, and that, with these as units, the distribution of species is well shown, whether frequent, local, or rare, by natural divisions, or by parishes and counties. By preparing *maps* of the species-distribution also, the record would be rendered very much more complete than has yet been accomplished in any published work on the flora or fauna of Scotland. From such local records a "Topographical Botany" of all Scotland could be prepared that would be found of very great value by our successors. Their preparation requires only industry, care, and accuracy, the critical species being submitted to experts for their verdicts.

Briefly summarising the views stated above, they express these conclusions:—

Much requires to be done before a complete account can be given of the flora of Scotland. The preparation for this demands the labour of many local botanists, each doing the work for a district around his home, or within so easy access as to permit of frequent visits. The local work done by them, and the general work resulting from their collaboration, should rest on the investigation of areas so planned as to be combined at will into parishes, counties, or natural districts, and such in size and in relation to environments as to show accurately the distribution as a whole, and any peculiarities of a noteworthy kind. For

each species and variety a map should be prepared to show the distribution, except where its rarity makes it desirable not to indicate the localities too minutely. The records should include, in the ordinary series, every species observed under such conditions as might lead to its being regarded as a wild plant (and in an appendix might be enumerated the plants cultivated in the country generally); but against each plant should be noted whether it appeared to be "native," or "alien," owing its presence in the district to man's agency, intentional or unintentional. In the latter case, its condition as observed should be noted, whether only a suspected "alien," or a "denizen," holding its place without man's aid, or a "colonist," continuing to grow as a weed of cultivated ground against man's will, or a "casual" merely, dying out after a time, or planted where found. It should also be noted of the "aliens," where possible, how they seemed to have been introduced, whether as outcasts, or escapes, or relics of cultivation, or with commercial products, etc. As to "native" plants, it might be stated whether their range of distribution or abundance was being altered noticeably by man or from natural causes.

For each district, at least of larger extent, the characteristic and local plants should be indicated, and also the immigrants from other districts, and those that reach a geographical limit in it. The grade of scarcity or of abundance should also be stated. Any plant-associations of a noteworthy kind, deserve mention. Information as to habitats, restriction to certain geological formations or soils, peculiar forms, associations with insects, either beneficial (as in pollination) or hurtful (galls or other injuries) diseases, and other matters of biological interest that might affect the flora might be included, or might form a companion volume to the "Topographical Botany of Scotland" of the future.

By the use of a few simple and easily understood contractions, local lists might easily give much more information on a good many of the above points than one usually finds in them, with very slight addition to their bulk.

Lastly, the progress of investigation of the flora is of much interest, and the earliest record of each plant in a

district should be noted, along with any noteworthy variation of frequency. Such notes are of peculiar interest with reference to immigrants.

## TOPOGRAPHICAL BOTANY OF THE RIVER-BASINS FORTH AND TWEED IN SCOTLAND. By JAMES W. H. TRAIL.

(Read 12th February 1903.)

The following brief outline of the progress of botanical investigation in the basins of the rivers Forth and Tweed (in Scotland), and the abstract of county-distribution of their floras, in so far as I have been able to ascertain it up to 1903 from published records and other sources of information, have been prepared in the hope that they may be found useful to field botanists in the south-east of Scotland, and may help towards the preparation of such a record of the Scottish flora as is much to be desired.

The counties included are Berwick, Roxburgh, Selkirk, Peebles, Haddington, Edinburgh, Linlithgow, Fife and Kinross, Stirling, and Perth and Clackmannan within the basin of the Forth. Parts of Fife and Stirling lie outside the basin of the Forth; but it is not possible, from the information within my reach, to determine from the records of the several plants published for these counties whether they refer only to parts of the counties beyond the Forth valley or to it also. Thus under these counties may be included a (very) few species not found in that valley. It has seemed more likely to be of use to include *all* species known to me to have been recorded for any of these counties, whether truly indigenous or introduced originally by man. In the floras and lists that enumerate the plants of the counties, there are too often no indications of whether the various plants are indigenous or aliens, and such information as is given is at times apparently misleading. I have sought, as far as my knowledge of the flora of Scotland would allow, to indicate which must be regarded as aliens (marked †), introduced intentionally or unintentionally by man. Attention has been drawn to the many defective records, especially for

certain counties, in the confident belief that many of these gaps will soon be filled. Probably materials exist in herbaria to add largely to what is on record.

In a compilation like the present, errors as well as omissions are inevitable; but it is hoped that they will be pointed out and corrected, and that it may aid in stimulating the progress of inquiry.

The south-east of Scotland was the earliest part of the country to receive investigation of its flora, Edinburgh being the centre where the study of botany began in Scotland. Sir Robert Sibbald's "Scotia Illustrata," issued at Edinburgh in 1684, contains much information, though in a form unfamiliar to us, about the plants known to him, and he frequently mentions localities for plants, mostly in the valley of the Forth, besides giving a list of species "in septo regio Edinburgensi sponte nascentium." Lightfoot's "Flora Scotica," which appeared in 1778, and again in 1789, gave a very great impulse to the study of the flora of Scotland. The information it contains on the basin of the Forth was derived mostly from Professor Hope, and from Mr. Yalden, who supplied a list of the plants found in the King's Park, and from the herbarium made by Dr. Parsons (Professor of Anatomy in Oxford), while studying in Edinburgh. Comparatively few localities in the district are named by him.

But a more important contribution to our knowledge of the flora of Edinburgh in the eighteenth century appeared only in 1900 in the "Annals of Scottish Natural History" in "A list of plants growing in the neighbourhood of Edinburgh, collected in flower 1765 (1764–65), as a sketch of the Calendarium Floræ of Edinburgh." Of this, found among the papers left by Professor Hope, and bequeathed by his grandson, John Hope, W.S., in 1895, to the Royal Botanic Garden, a copy was communicated to me by Professor Balfour for publication. The records are not quite so restricted as the heading implies.

Greville's "Flora Edinensis" (1824) is devoted to the "Flora of the environs of the Scottish Metropolis," "to the distance of ten miles," "with very few exceptions." The localities are seldom quoted from the earlier records, but are mostly based on the field work of the author,

and of Messrs. George Don, Patrick Neill, R. Maughan, and Walker Arnott as regards the vascular plants.

In 1824 also, Mr. J. Woodfoorde published a small book, "Indigenous Phænogamic Plants . . . of Edinburgh." Mr. H. C. Watson's "New Botanist's Guide" (in Vol. II., 1837) enumerates some of the rarer plants, under the several counties.

Field work by students of the University has been stimulated by the custom, begun by Professor Hope and continued by his successors, of giving a medal for the best herbarium collected within twenty miles of Edinburgh; and weekly excursions during summer have long been a custom of the botanical classes. Much information has been accumulated by these means, as well as by the investigations of botanists resident in various localities, some of the results of which have appeared in various journals, including the Transactions of this Society. The "Flora of Edinburgh," issued by Prof. J. H. Balfour and John Sadler (in 1863, 2nd Ed. in 1871), brought together much of the additional information in a handy form. Mr. H. C. Watson's "Topographical Botany," issued privately to the author's correspondents in 1873–74, stated the results (as known to him, and accepted by him as trustworthy in regard to indigenous and well-naturalised species) in tabular form under the several counties. A second edition of this work appeared in 1883, with many additions to lists from counties in other parts of Great Britain, but not many from the basin of the Forth. Mr. Watson had the advantage of the aid of Professors J. H. and I. B. Balfour, and of Dr. Boswell, who sent him catalogues of the plants known from the counties around Edinburgh on both sides of the Forth; and he also made use of a catalogue of the plants of Stirlingshire, published in 1875 by Mr. Croall.

In 1894 appeared "A Pocket Flora of Edinburgh and the surrounding District," by C. O. Sonntag. In the preface it is stated that "the localities given are taken partly from the late Professor Balfour's catalogue, and partly from my own collection" (the latter, for rarer plants, being marked with an asterisk), and that the district of the flora measures "from thirty to forty miles in diameter."

Since 1886 onwards, Mr. Arthur Bennett has contri-

buted a list of additions to the county records of Scottish plants, compiled from the published notes of numerous botanists, English as well as Scotch; and among these additional records a good many relate to south-east Scotland. The flora of the county of Stirling has been very carefully investigated by Colonel Stirling and Mr. R. Kidston since the issue of the second edition of "Topographical Botany," and the additions discovered by them have been published in the "Transactions of the Stirling Natural History Society." As part of the county is in the Clyde basin, some of the records from it may not refer to the Forth valley, but these are not many.

The flora of Perthshire in the Forth basin (West Perth of "Top. Botany") is among the better known in Scotland, thanks to Dr. F. B. White's "Flora of Perthshire" (1898), and to subsequent papers on *Rubi* by Rev. W. Moyle Rogers, and on *Rosa* by Mr. W. Barclay.

The basin of the Tweed has been the scene of much careful work, and its flora in Scotland has been made known by J. V. Thompson's "Catalogue of Plants growing in the vicinity of Berwick-upon-Tweed" (1807), by Dr. George Johnston's "Flora of Berwick-on-Tweed" (1829–31), and "Natural History of the Eastern Borders" (1853), and in the excellent publications of the Berwickshire Naturalists' Club, and in other scientific journals, as well as in the works of H. C. Watson already referred to.

In view of the length of time during which investigation of the flora of the basins of the Forth and the Tweed has been in progress, of the number of collections that have been made, especially around Edinburgh, of the high and well-deserved reputation of the botanists that have taken part in the work, and of the numerous published books and memoirs recording the results of their labours, it might well seem that there can be little remaining uninvestigated in either district, and that it is presumption in one that has done so little field work as I in south-east Scotland to criticise the labours of others. But the preparation of the census of Scottish plants made me aware of the gaps in the records for the several counties, and showed that it would not be possible to prepare a flora for any county in the country that could give a true and complete view of it at

the present time and could serve as a standard for comparisons in future. The north-east counties have been among the less deficient, owing to the labours of local botanists from Forfar to Moray, and to the renown of Clova and Braemar as homes of alpine species. Yet in even this comparatively well-known district I have found it impossible from published records to gain a true conception of the actual distribution of species. A few localities have been well explored, but from many parishes there is not a species on record, nor are there sufficient indications of relative abundance, of relations to man, and of other points that should be noted. My experience of the need, even in these counties, of widely extended field work with the new queries kept consistently in view, has shown me the value of such work, and the great need of it in all the Scottish counties, though necessarily in some far more than in others. One would hardly anticipate that in 1883, when the second edition of "Topographical Botany" was published, Peebles should have been one of the two counties of Great Britain (out of 112 in all) from which few of the commonest plants could be certified. Though a good many additions have been made to the records for Peebles since then, it is still one of the most poorly represented of all the British counties. In the "Flora of Edinburgh," by Balfour and Sadler, and in that by Sonntag, "Linton" is occasionally given as a locality. I suppose this means West Linton in Peebles. "Pentland Hills" are also not infrequent for species, some of which must certainly exist in Peebles; but without fuller information this habitat does not allow of certainty as to the county to which it belongs. Selkirk is also less often noted in the lists than it certainly should be; and Roxburgh is omitted at times when one would expect to find it included. Haddington and Linlithgow both show frequent gaps in the local records, in not a few cases these relating to species that can scarcely be absent from the counties. Edinburgh is one of the richest of all the counties of Scotland in number of species recorded from it, but its critical genera and species (*e.g. Ranunculus acris*, *Fumaria capreolata*, agg., *Rubus*, *Rosa*, *Hieracium*, *Euphrasia*) require revision. It is unlikely that many additions will be made

to the lists for Edinburgh, Fife and Kinross, Stirling, and West Perth and Clackmannan, yet even in these counties there is need of more thorough exploration, in view of the requirements specified above. No doubt much information would be obtained from a careful examination of the local collections in the Herbarium in the Royal Botanic Garden.

In the hope of aiding in the investigation of the basins of the Forth and the Tweed, I have sought to prepare a list, showing what species that might be expected to occur in each county have not yet been reported from it, using H. C. Watson's numerals for the counties (78 Peebles, 79 Selkirk, 80 Roxburgh, 81 Berwick, 82 Haddington, 83 Edinburgh, 84 Linlithgow, 85 Fife with Kinross (partly in the basin of the Tay), 86 Stirling (partly in the basin of the Clyde), 87 W. Perth with Clackmannan. I have in some cases enumerated those counties from which a plant is recorded; when a plant occurs in most counties I have sought to draw attention to those from which it has not been recorded by the words, *Not from*, followed by their *numbers in italics.* "Aliens" are denoted by † before the numbers, or after single numbers; (S.) denotes Sonntag as the authority; (F.E.) denotes Balfour and Sadler's "Flora of Edinburgh."

## DICOTYLEDONS.

Clematis vitalba, L.—† in 82, 83, 85, 87.
Thalictrum.—The aggregate, T. minus, L., is recorded from all the counties except Peebles, but the forms under it are not noted except dunense, Dum., in Haddington, Edinburgh, and Fife.
—— majus, Crantz (as T. flexuosum), is recorded only from 85 (North Queensferry) and 87.
—— flavum, L.—81, 83, 85.
Anemone nemorosa, L.—In all.
Ranunculus aquatilis, L.—As an aggregate is recorded from all Scotland, but the numerous forms have seldom been well wrought out.
—— circinatus, Sibth.—83, 84 (S.), 85, 86, 87.
—— fluitans, Lam.—80, 81, 85 (F.E.), 86 (S.).
—— trichophyllus, Chaix.—80, 82, 83, 85, 86.
—— Drouettii, Godr.—79, 83.
—— heterophyllus, Web.—Doubtfully recorded from 85 in "Top. Bot."
—— peltatus, Schrk.—78, 79, 80, 83, 85, 87; and *var.* floribundus, 83.
—— Baudotii, Godr.—80 (?), 81 (?), 82, 83, 84, all from "Top. Bot.," along with *var.* confusus, Godr.

Ranunculus Lenormandi, F. Sch.—Is recorded by Sonntag from 83, 84, 85, 87.
— hederaceus.—From all.
— sceleratus, L.—Recorded from all except 79 (if "Linton" in F.E. refers to Peeblesshire).
— Flammula, L.—From all. *Var.* radicans, Nolte., is no doubt common, though recorded only from 86.
— reptans, L.—85, by a few lochs, especially Loch Leven.
— Lingua, L.—*Not from 78 and 82.*
— auricomus, L.—*Not from 78 and 84.*
— acris, L.—From all, but the forms not distinguished.
— repens, L.—Common in all.
— bulbosus, L.—*Not from 84.*
— sardous, Crantz.—Is this perhaps alien, though frequent? It is recorded from 80, 81, 83, 84, 85, 86, 87.
— arvensis, L.—81, 82, 83, 84. Is this more than an alien?
— Ficaria, L.—In all. *Var.* incumbens, F. Sch., must occur, though not on record south of Perth.
Caltha palustris, L.—In all. *Var.* minor, Syme, Pentland Hills (in which county?), 86, 87.
Trollius europæus, L.—*Not from 82.*
Helleborus viridis, L.—An escape or casual in 81, 82, 83, 85.
— fœtidus, L.—As escape or casual in 80, 81, 82, 83, 85, 86.
Eranthis hyemalis, L.—Woods and pastures in 83 and 87; introduced.
Aquilegia vulgaris, L.—A denizen or casual in 79, 83, 84, 85, 86, 87.
Aconitum Napellus, L.—A frequent introduction, by streams in 81, 83, 85, 86.
Actæa spicata, L.—A rare alien, in 83.
Berberis vulgaris, L.—Recorded from every county, but no doubt an alien.
Epimedium alpinum, L.—Introduced into woods in 83, 85, 87.
Nymphæa lutea, L.—*Not from 78, 84.* *Var.* intermedia, Ledeb., has been found in 86.
— pumila, Hoffm.—On record from 86, 87.
Castalia speciosa, Salisb.—79, 80, 81, 83, 84, 85, 86, 87. Possibly introduced into some places.
Papaver.—It may be questioned if any of the species is more than a colonist, while several are mere casuals, *e.g.* P. somniferum, L., in 82, 83, 85, 86, 87.
— Rhœas, L.—*Not from 79* (78 (?) at Linton). *Var.* strigosum, Bœnn., 87.
— dubium, L.—In all.
— Argemone, L.—*Not from 78, 79.*
(P. hybridum, L.—Recorded in F.E., as in Hb. Grev., from 83, was probably only a casual.)
Meconopsis cambrica, Vig.—† in 82, 83, 85, 86, 87.
Glaucium flavum, Crantz.—Recorded from 81, 82, 84, 85, is apparently on the way to extinction
Chelidonium majus, L.—A frequent introduction in all the counties, almost a denizen occasionally.
Neckeria bulbosa, N.E. Br.—† in 82; and N. lutea, Scop., † in 83, 85, 86.
— claviculata, N.E. Br.—*Not from 78, 79, 82.*
Fumaria capreolata, L.—The aggregate is recorded from all except 78, but the forms under that aggregate are much in need of revision. The following records are found, but cannot be accepted as authoritative:—pallidiflora, 79†, 80; Boræi, 80, 81, 82, 85, 86, 87; confusa, 85, 86, 87; muralis, 86.

Fumaria densiflora, DC.—*Not from 78, 79, 81, 86, 87.*
—— officinalis, L.—In all.
—— Vaillantii, Lois.—83.
—— parviflora, Lam.—80†, 82, 83 (?), 85 (?), 86, 87.

The species of Fumaria in Scotland can scarcely be regarded as other than colonists.

Cheiranthus Cheiri, L.—On old ruins, and occasionally on rocks; †82, 83, 85.
Nasturtium officinale, R. Br.—In all.
—— sylvestre, R. Br.—81, 83, 85, 86, 87. In which counties is this native beyond question?
—— palustre, DC.—*Not from 79.*
—— amphibium, R. Br. (as Armoracia amphibia, Koch.).—In F.E., from 83 and 85, but requires confirmation.
Barbarea vulgaris, R. Br.—In all.
—— stricta, Andrz —†, 86.
Arabis Turrita, L.—†. Does this still occur on any ruins in the counties?
—— hirsuta, Scop.—In all.
—— perfoliata, Lam.—80 and 87. "Doubtfully native," "Top. Bot."
Cardamine amara, L —*Not from 78, 82, 84.*
—— pratensis, L.—In all.
—— hirsuta, L.—In all.
—— flexuosa, With.—*Not from 84.*
—— impatiens, L.—"Debris of Salisbury Crags," but not native.
Alyssum calycinum, L.—Denizen or casual in 82, 83, 85 (S.)
—— maritimum, L.—Casual in 85 (S.)
Draba muralis, L.—Recorded (as a doubtful native, or †, or casual) from 80, 83, 85, 86, 87.
—— incana, L.—87.
Erophila præcox, DC.—85.
(—— inflata, Hook. fil.—May be found, as it occurs in Perthshire.)
—— vulgaris, DC.—In all.
Cochlearia officinalis, L.—From all the counties, but 79 † and 80 (?).
—— alpina, H. C. Watson.—78, 80, 86, 87.
—— danica, L.—81 (?), 83, 85, 87.
—— anglica, L.—83 (S.), 85 (S.).
(—— grœnlandica, L.—Should be looked for in short turf on bare, rocky coasts.)
—— Armoracia, L.—83, 85, 87. Escape or outcast.
Hesperis matronalis, L.—Escape or outcast, 83, 87.
Sisymbrium Thalianum, J. Gay.—In all.
—— officinale, L.—In all, but is it always clearly native? The *var.* leiocarpum, DC., should be looked for.
—— Sophia, L.—80 †, 81, 82, 83, 85, 86.
—— polyceratium, L.—†, 83.
—— pannonicum, Jacq.—Casual in 86; may be expected elsewhere.
—— Alliaria, Scop.—In every district. In north-east Scotland it is a very doubtful native.
Erysimum cheiranthoides, L.—A not uncommon casual, 80, 81, 84, 85.
—— orientale, R. Br.—Casual in 86.
Camelina sativa, Crantz.—Casual in 87; and *var.* fœtida, Fr., casual in 85.
Subularia aquatica, L —85 (?), 86 (S.), 87.
Brassica.—The cultivated species (cabbage, turnips, rape, black mustard) have all been recorded more or less frequently from some of the counties, but they are mere casuals.

Brassica alba, Boiss.—Recorded from all except 78 (usually without intimation of not being native); can scarcely be regarded as even a colonist.
—— Sinapistrum, Boiss.—Is a colonist in every county.
—— monensis, Huds.—82 (?). "Top. Bot."; not in Floras of Edinburgh.
Diplotaxis tenuifolia, DC.—Given as a doubtful native in 81, 85; there can be no doubt is † there, as well as in 86.
—— muralis, DC.—80 (?), 82 (?) †, 85 †, 86 (?), 87 †. The claim of this to be considered native anywhere in the district is very questionable.
Bursa Bursa-pastoris, Weber.—In all. Is not this at most only a denizen in Scotland?
Coronopus didymus, Sm.—† in 85, 86, 87.
—— Ruellii, All.—*Not from 78, 79, 84.* Only casual in 87. Its distribution suggests doubt of its being native in Scotland.
Lepidium latifolium, L.—Recorded from 80, 81, 82, 85 as a doubtful native, but no doubt †.
—— ruderale, L.—† little more than a casual in 80, 83, 85, 86, 87.
—— campestre, R. Br.—*Not from 78, 79, 80.*
—— hirtum, Sm.—*Not from 78.*
—— sativum, L.—As a casual in 83 and 85.
—— Draba, L.—As a casual in 85.
Thlaspi arvense, L.—*Not from 86.* A colonist only.
Iberis amara, L.—† in 79, 80, 81, 83, 85, 87; but seldom more than a casual.
Teesdalia nudicaulis, R. Br.—*Not from 82, 84, 86, 87*, but should be found in one or more.
Isatis tinctoria, L.—A casual, 82, 83.
Crambe maritima, L.—81, 84, 85, on sandy seashores.
Raphanus Raphanistrum, L.—A colonist. *Not from 86.*
—— maritimus, Sm.—"Seacoast, near Elie"; F.E.
Reseda lutea, L.—Given (usually without query as to its being native) from 81, 82, 83, 84, 85, 87, but †.
—— Luteola, L.—*Not from 78.* Elsewhere given as native, but its claim to be so seems to require investigation.
—— alba, L.—A casual on sandy soil, in 83, 84, 85, 86 (S.).
Helianthemum Chamæcistus, Miller.—*Not from 84.*
Viola palustris, L.—In all.
—— odorata, L.—Is reported from 80, 81, 82, 83, 85, 86, 87, often as if native, but no doubt †.
—— hirta, L.—80, 81, 82, 83, 85.
—— Riviniana, Reichb (V. sylvatica, Fr.).—In all
—— silvestris, Reichb.—84.
—— ericetorum, Schrader.—*Not from 79, 80, 81.*
—— lactea, Sm.—78 (?).
—— tricolor, L.—In all.
—— arvensis, Murray.—No doubt in all, though not specially recorded from some counties.
(—— Curtisii, Forster.—Has not been detected in the district, but should be found on sandy coasts.)
Polygala vulgaris, L.—The aggregate is reported from all *except 79*; but the segregate only from 86 (Ewing), and P. serpyllacea. Weihe, only from 78, 81, 82 (S.), 83, 85, 86, 87.
Dianthus Armeria, L.—†, 80 (?), 83, 85 (?).
—— barbatus, L.—†, 83.
—— deltoides, L.—*Not from 79, 80, 86.* *Var.* glaucus, L., 83.
—— cæsius, Sm.—†, 83.

Dianthus Caryophyllus, L.—†, (Inchcolm) 85.
Saponaria officinalis, L.—†, 83, 84, 85, 87.
Silene Cucubalus, Wibel.—In all; but *var.* puberula, Syme, only from 82, though no doubt in other counties also.
—— maritima, With.—*Not from 78, 79, 80, 86.*
—— Armeria, L.—Casual in 83, 84.
—— conica, L.—82, 83 (S ).
—— anglica, L.—80†, 82, 83, 85, 86†. A doubtful native.
—— quinquevulnera, L.—Casual in 83.
—— acaulis, L.—On high hills in 86, 87.
—— nutans, L.—Very local in 85.
—— italica, Pers.—†, 83.
—— noctiflora, L.—80, 81 (?), 82, 83 (?), 85, 86, 87†. A colonist in some of its habitats.
Lychnis alba, Miller.—*Not from 80.*
—— dioica, L.—In all.
—— Flos-cuculi, L.—In all.
—— Viscaria, L.—80, 83, 85, 86, 87.
—— Githago, Scop.—*Not from 78, 79.* This, in Scotland, so far as I have seen, is barely a colonist.
Cerastium tetrandrum, Curtis, and C. semi-decandrum, L.—*Not from 78, 79, 84.*
—— glomeratum, Thuill.—In all. The *var.* apetalum, Dum., though not recorded is probably not rare.
—— triviale, Link.—In all. The varieties have not been distinguished within the district.
—— alpinum, L.—86, 87, on hills.
—— arvense, L.—*Not from 78, 84.*
Stellaria aquatica, Scop.—80 (?), 86.
—— nemorum, L.—*Not from 78, 82, 84.*
—— media, L.—In all. The varieties have not been wrought out for Forth or Tweed.
—— umbrosa, Opiz.—85.
—— Holostea, L.—In all.
—— palustris, Retz.—*Not for 78, 79, 82 (?), 84.*
—— graminea, L.—In all.
—— uliginosa, Murr.—In all.
Arenaria verna, L.—81, 83, 85 (S.).
—— tenuifolia, L.—Has been recorded from 83, 84 (S.), 85, 86 (S.).
—— trinervia, L.—*Not from 78.*
—— serpyllifolia, L.—The *aggregate* is recorded from all the counties, but of the varieties, only leptoclados, Guss., from 87.
Sagina apetala.—The aggregate from all *except 78, 79.* The segregate from 81, 82, 83, 86, 87.
—— maritima, Don.—82, 83, 84, 85, 86, 87. No variety has been recorded from Forth or Tweed.
—— ciliata, Fr.—80, 81, 82, 83, 85, 86, 87. (F.E. does not give this for 83.)
—— procumbens, L.—In all.
—— subulata, Presl.—*Not from 78, 79, 80, 82.*
—— nodosa, Fenzl.—*Not from 78.*
Spergula arvensis, L.—The aggregate from all counties (a colonist), but the forms not distinguished, though, no doubt, sativa, Bœnn., is that meant; *var.* vulgaris, Bœnn., should be looked for.
Buda rubra, Dum.—*Not from 78, 79.*
—— marina.—The aggregate from 81, 82, 83, 85, 87. *Var.* neglecta, Kindb., 81, 85, 86, 87.

Buda media, Dum.—85, 86 (S.).
Polycarpon tetraphyllum, L.—80 (?), casual in 86.
(Claytonia sibirica, L., and C. perfoliata, Donn. may be looked for as semi-naturalised in damp woods, often looking much like natives).
Montia fontana, L.—*Not from 79, 82.* The forms have not been recorded from Forth or Tweed.
Elatine hexandra, DC.—86, 87.
Hypericum Androsæmum, L.—Woods in 80, 81, 83, 85, 86, 87; †, though not always so recorded.
—— calycinum, L.—† in 82, 85, 87.
—— quadrangulum, L.—The aggregate from all.
—— dubium, Leers.—78, 79, 81, 84, 85 (?), 86, 87,
—— quadratum, Stokes.—*Not from 78 and 84.*
} It would be well to have these revised and confirmed.
—— humifusum, L.—*Not from 78 and 84.*
—— pulchrum, L.—In all.
—— hirsutum, L.—*Not from 84.*
—— elodes, L.—Sonntag gives this for 83 and 86.
Althæa officinalis, L.—†, 86 (?).
Lavatera arbosea, L.—82, Bass, and 85, Elie; very doubtfully native.
Malva moschata, L.—*Not from 78, 79, 84.*
—— sylvestris, L.—*Not from 78, 79.*
—— rotundifolia, L.—*Not from 79, 84.*
The claim of these mallows to be ranked as natives is at least doubtful. In the "Flora of Perthshire" they are regarded as † or as mere casuals.
Tilia.—Of this genus, the numerous trees do not often seem to spring from self-sown plants, most having been evidently planted.
—— platyphyllos, Scop., T. europæa, Hayne, and T. cordata, Miller, all occur as ornamental trees in the district.
Radiola linoides, Roth.—80, 81, 82 (S.), 83 (S.), 85, 86, 87.
Linum catharticum, L.—*Not from 78.*
—— perenne, L.—83, a casual.
—— usitatissimum, L.—Relic of cultivation, or casual in 82, 83, 84, 85, 86, 87.
Geranium sanguineum, L.—*Not from 78, 79, 84, 87.*
—— nodosum, L.—† in 83, 84.
—— phæum, L.—† in 82, 83, 84, 85, 87.
—— sylvaticum, L.—In all.
—— pratense, L.—In all.
—— pyrenaicum, Burm. f.—80, 83, 85. Is this truly native?
—— molle, L.—In all.
—— pusillum, L.—80, 81, 82, 83, 84 (S.), 85, 86, 87 cas. Near Aberdeen I have never found this, though it has been recorded from there. Are all the above figures trustworthy?
—— rotundifolium, L.—(?) † in 82, 83, "Top. Bot."; not in F.E.
—— dissectum, L.—In all.
—— columbinum, L.—80, 82 (S.), 83, 85, 86.
—— lucidum, L.—*Not from 78, 79.* Is it not sometimes an escape, or planted?
—— Robertianum, L.—In all.
Erodium cicutarium, L'Herit.—*Not from 78, 79.*
—— moschatum, L'Herit.—Casual.
Oxalis Acetosella, L.—In all.
(—— corniculata, L.—A weed, †, in gardens, near Aberdeen, may be looked for.)

Impatiens Noli-tangere, L.—† in 80, 83, 84 (S), 87, casual.
Ilex Aquifolium, L.—*Not in 78.*
Euonymus europæus, L.—80, 81, 83 (84, 85) (?) †, 86†. Is this native in the district?
Rhamnus Frangula, L.—† in 86, and no doubt in other counties also.
Acer Pseudoplatanus, L.—†, and very often self-sown thereafter, probably in all the counties.
(—— platanoides, L.—No doubt commonly planted, though not recorded.)
—— campestre, L.—Recorded from 78, 80, 81, 83, 84, 85, 86, 87, often with no indication of alien origin, yet a doubtful native anywhere in Scotland.
Genista anglica, L.—*Not from 84.*
—— tinctoria, L.—78 (S.), 80, 81, 83 (?), 84, 85 (?).
Ulex europæus, L.—In all.
—— Gallii, Planch.—Pentland Hills (Sonntag, (? 78 or 83), 80, 86 (S.), 87 (S.)
—— nanus, Forst.—Very doubtfully in 81, 83, 85.
Cytisus scoparius, Link.—In all.
Laburnum alpinum, J. S. Presl., and L. vulgare, J. S. Presl., are frequent in all districts in shrubberies, and often spring up from the seed of the introduced plants, so as to appear at times almost wild.
Ononis repens, L.—In all.
—— spinosa, L.—81, 82, 83, 85 (?), 86, 87 (S.). Owing to the confusion between O. spinosa and *var.* horrida of O. repens, L., these records should be revised.
Trigonella purpurascens, Lam.—83, 85.
Medicago sativa, L.—†, 83, 84, 85, 86, 87.
—— falcata, L.—86, casual.
—— lupulina, L.—In all.
—— denticulata, Willd.—†, 78, 80, 85, 86. Merely a casual usually.
—— arabica, Huds. (M. maculata, Sibth.)—† in 78, 80, 83, 84 (S.), 85, 86, 87, as a casual usually.
Melilotus officinalis, Lam.—*Not from 78, 79, 84.* From 81, 82, 83, given as if native; from 80, 85, 86 as probably †; and from 87 as †. A doubtful native.
—— alba, Desr.—*Not from 78, 79, 84.* From all the remaining counties as †, or probably so.
—— arvensis, Wallr.—85, 86, casual. (A common casual near Aberdeen.)
—— indica, All.—†, 86, casual.
Trifolium pratense, L.—In all.
—— medium, L.—In all.
—— squamosum, L.—Casual in 86.
—— incarnatum, L.—A relic of, or casual from, cultivation. 82, 83, 84.
—— arvense, L.—*Not from 84.*
—— striatum, L.—*Not from 78, 79.*
—— scabrum, L.—82, 83, 85.
—— hybridum, L.—Generally cultivated and casual. *Not 79, 80, 81.*
—— repens, L.—In all.
—— fragiferum, L.—Given in "Top. Bot." for 81, 82, 83, 85 (not in F.E. for 83, 85).
—— agrarium, L.—86†. "Common in pastures and roadsides" (Sonntag), but apparently in error for true T. procumbens, L.; the latter name apparently applied to T. dubium, Sibth., which he does not mention, though it may be included under his T. filiforme, L.

Trifolium procumbens, L.—*Not from 78.*
—— dubium, Sibth.—In all, usually under the name of T. minus, Sm.
—— filiforme, L.—80, 82, 83, 84, 85. These records should be verified.
Anthyllis Vulneraria, L.—*Not from 78.*
Lotus corniculatus, L.—In all.
—— tenuis, Waldst. and Kit.—80 †, 81, 82, 83, 84, 85, 87 (?). Should be verified.
—— uliginosus, Schkuhr.—In all.
Astragalus danicus, Retz.—*Not in 78, 79, 80, 86.*
—— glycyphyllus, L.—*Not in 78, 79.*
Oxytropis uralensis, DC.—85, 87 (?).
Ornithopus perpusillus, L—83, 85, 86, 87
Onobrychis viciæfolia, Scop.—82. 83, 84 (S.), 85 (?). Not noted as †, yet probably so.
Vicia hirsuta, Gray.—In all.
—— gemella, Crantz.—80, 83, 85 †, 86 casual, 87 (?) †. Probably not native.
—— Cracca, L.—In all.
—— Orobus, DC.—*Not from 79, 82, 86* (S.), *87.*
—— sylvatica, L,—*Not from 84.*
—— sepium, L.—In all.
—— lutea, L.—83 ("Top. Bot.," not in F.E.), 84 (S.), 85, 86 (S.).
—— sativa, L.—Frequent casual, or escape from cultivation.
—— angustifolia, L.—*Not from 78, 79, 81* (?).
—— lathyroides, L.—*Not from 78, 79, 84, 87.*
Lathyrus Aphaca, L.—Casual in 83.
—— pratensis, L.—In all.
—— latifolius, L.—† in 83.
—— sylvestris, L.—81, 83, 87, probably escapes.
—— montanus, Bernh.—In all. *Var.* tenuifolius, Reichb. f. Recorded from 83.
Prunus spinosa, L.—In all.
—— insititia, Huds.—80, 81, 83, 85, probably † in all.
—— domestica, L.—† in 83, 85 (S.), 86.
—— Avium, L—*Not in 84.*
—— Cerasus, L.—† 83, 87.
—— Padus, L.—In all.
Spiræa salicifolia, L.—A frequent ornamental shrub, † in 83, 85, 86, 87.
—— Ulmaria, L.—In all.
—— Filipendula, L.—81, 83, 85, 87 (S.), probably †.
Rubus idæus, L.—In all. *Var.* obtusifolius, Willd., 85, 86; *var.* asperrimus, Lees, 87.

The "Brambles" of the Forth and Tweed valleys have been investigated by the Rev W. Moyle Rogers in West Perth, and (less fully) in 81, 84, and 86, but the lists for the other counties are in want of thorough revision. That being so, and the distribution of these plants throughout having been fully discussed in the recent numbers of the "Annals of Scottish Natural History," I shall not take up space by repeating the list here.

—— saxatilis, L.—*Not from 82, 84.*
—— Chamæmorus, L.—*Not from 81, 82, 84, 85.*
Geum urbanum, L.—In all.
—— rivale, L.—In all.
—— rivale × urbanum (=G. intermedium, Ehrh.).—*Not from 78, 84.*
Fragaria vesca, L.—In all.

Fragaria elatior, Ehrh.—Recorded as an escape in 82, 83, 85. Other cultivated forms may also be among those occasionally found on waste ground and by roads.
Potentilla norvegica, L.—86, casual.
—— recta, L.—82 and 85, casual.
—— verna, L.—81, 82, 83, 85 (S.).
—— silvestris, Neck. (P. Tormentilla, Scop.).—In all.
—— procumbens, Sibth.—*Not from 78, 79, 82, 84.*
—— reptans, L.—*Not from 84.*
—— Anserina, L.—In all.
—— rupestris, L.—83 (?).
—— argentea, L.—*Not from 78, 79, 86.*
—— fruticosa, L.—† in 83, 85, 87 (S.).
—— palustris, Scop.—*Not from 78.*
—— Sibbaldi, Hall. f.—78, 86, 87, on high hills.
Alchemilla arvensis, L.—In all.
—— vulgaris, L.—From all the counties, but the varieties recorded only from—pratensis, Schmidt, 83, 86; alpestris, Schmidt, 86; filicaulis, Buser, 86.
—— alpina, L.—86, 87, on hills.
(—— argentea, Lam.—Probably may be found as an outcast or escape.)
Agrimonia Eupatoria, L.—*Not from 84.*
—— odorata, Miller.—86.
(Aremonia agrimonioides, DC.—Occurs as an escape or outcast in various parts of Scotland, and probably here also.)
Poterium Sanguisorba, L.—80, 81, 82 †, 85 †.
—— officinale, Hook. f.—79, 80, 81.
Rosa.—In this genus, as among the Brambles, there is much need of a careful and thorough revision of the records and herbaria, in light of the conclusions arrived at in recent years. Mr. W. Barclay has lately done much by papers and personal field work to remove the difficulties that beset the study of the Roses of Scotland. It appears scarcely worth while to enumerate the older determinations of the varieties under R. canina and others, both species and varieties being accepted now in widely different significance in a good many cases.
—— pimpinellifolia, L. f., spinosissima, L.—In all.
—— involuta, L.—(Now regarded as made up of hybrids) 79, 81, 82, 83, 84. *Var.* Sabini, Woods. 81, 82, 83, 84.
—— mollis, Sm.—*Not from 82, 84.*
—— tomentosa, Sm.—In all.
—— rubiginosa, L.—*Not from 78, 79, 80.* Generally regarded as a doubtful native in Scotland, though often its habitats look much like those of a truly native species.
—— canina, L., R. glauca, Vill., and R. coriifolia, Fr., have not been distinguished in the past in this part of Scotland, hence the records are not trustworthy.
—— arvensis, Huds.—† (?) in 82, 83, 86.
—— sempervirens, L., and R. alpina, L., have been recorded from 84, but had been planted, or were escaped.
Pyrus Aria, L.—81, 83, 85, 86, probably †, though not always marked so. No doubt in the other counties also.
—— intermedia, Ehrh.—† in 85, 87.
—— Aucuparia, Ehrh.—*Not from 84.*
—— communis, L.—83, 84, no doubt †.
—— Malus, L.—78, 80, 81 (?) †, 83, 84, 86 †, 87. Probably † in some at least of these, and requiring revision, the forms under the species not being distinguished.

Cratægus Oxyacantha, L.—From every county, yet a doubtful native. The varieties have not been distinguished in the records, except monogyna, Jacq., from 87.
Saxifraga oppositifolia, L.—Pentland Hills (? which county), 86, 87.
—— stellaris, L.—78, 79, 85, 86, 87.
—— Geum, L.—Outcast or casual in 83, 85.
—— umbrosa, L.—† in 82, 83, 85, 86, 87.
—— Hirculus, L.—81, 87 †. Is not the "Source of the Medwyn, Pentland Hills, eighteen miles south-west of Edinburgh" in 78? "Top. Bot." omits 78, but gives 83.
—— aizoides, L.—86, 87.
—— tridactylites, L.—79, 82, 83, 84, 85, 87.
—— granulata, L.—In all.
—— hirta, Haw.—86, 87.
—— hypnoides, L.—78, 83, 85, 86, 87.
Chrysosplenium oppositifolium, L.—In all.
—— alternifolium, L.—*Not from 84.*
Parnassia palustris, L.—*Not from 78.*
Ribes Grossularia, L.—Recorded as "doubtful native" from 78, 83, 85, 86, 87. No doubt in every county, but only as a denizen or casual.
—— alpinum, L.—"Probably introduced." 80, 81, 83, 84, 86, 87. I have not seen this as a native in Scotland.
—— rubrum, L.—"Probably introduced." 83, 86, 87 †. The varieties have not been recorded except for 87, whence sativum and petræum are given as †.
—— nigrum, L.—"Probably introduced." 83, 85, 87 †.
Cotyledon Umbilicus, L.—87. (Escape or planted?).
Sedum roseum, Scop.—Pentland Hills (which county?). 81, 83, 85, 86, 87.
—— Telephium, L.—*Not from 78, 84.* Marked † from 85, 86, 87, but not from the other counties, yet its claim to be reckoned native in Scotland is very doubtful. The *var.* Fabaria, H. C. Watson, is named from 79 and 87 †.
—— villosum, L.—*Not from 82.*
—— album, L.—† in 82, 84 (S.), 85 (S.), 85.
—— dasyphyllum, L.—† in 82, 83, 85 (?), 87.
—— anglicum, Huds.—82 (S.), 85, 86, 87.
—— acre, L.—*Not from 79.*
—— reflexum, L.—†, in 82, 83, 85, 86, 87.
—— rupestre, L.—† 86.
Sempervivum tectorum, L.—† in 82, 83, 85.
Drosera rotundifolia, L.—*Not from 84.*
—— anglica, Huds.—81 (extinct?), 84, 85, 86, 87.
—— intermedia, Hayne.—85 (?) in "Top. Bot."
Hippuris vulgaris, L.—*Not from 78, 84.*
Myriophyllum spicatum, L.—*Not from 79, 81, 82.*
—— alterniflorum, DC.—*Not from 79, 82.*
Callitriche stagnalis, Scop.—*Not from 84.*
—— hamulata, Kuetz.—83, 86, 87.
—— autumnalis, L.—80, 82 (S.), 83, 85, 86, 87.
Peplis Portula, L.—79, 81, 83, 85, 86, 87.
Lythrum Salicaria, L.—79, 80, 81, 82, 83 (S.), 85 †, 86, 87.
Epilobium angustifolium, L.—*Not from 78.* With † in 85.
—— hirsutum, L.—*Not from 78.*
—— parviflorum, L.—*Not from 78, 84.*
—— roseum, Schreb.—82 (S.), 83, 85 (?), 86.
—— tetragonum, L.—This aggregate is *not reported from 84.*

Epilobium adnatum, Griseb.—83 (?), 87 (?).
—— obscurum, Schreb.—*Not from 81, 82, 84.*
—— alsinefolium, Vill.—80, 85, 87.
—— anagallidifolium, Lam.—85, 86, 87.
Several hybrids of this genus have been found in 86 by Messrs. Stirling and Kidston.
Œnothera biennis, L.—† or casual in 83, 84, 85, 87.
Circæa lutetiana, L.—*Not in 78, 84.*
—— alpina, L.—Has been recorded from 82, 83, 85, 86, 87.
—— intermedia, Ehrh.—79, 81, 83, 86. Owing to the two last forms being seldom distinguished clearly in local lists, the records for them are very uncertain.
Hydrocotyle vulgaris, L.—*Not from 78 (?) and 80.*
Eryngium maritimum, L.—Recorded from 82, 83, 85, 87. Does it still exist in these?
Astrantia major, L.—An occasional outcast or planted, 84, 86.
Sanicula europæa, L.—*Not from 78.*
Conium maculatum, L.—*Not from 78* (?). Is this certainly native in Forth or in Tweed?
Smyrnium Olusatrum, L.—81, 82, 83, 85, 86 (escape), 87. The evidence for this being native in Scotland requires confirmation.
Apium graveolens, L.—Escape or casual in 83, 85, 87.
—— nodiflorum, Reichb. f.—80, 81, 82, 83, 84, 85. *Var.* repens, Hook f., 82, 83.
—— inundatum, Reichb. f.—*Not from 78, 79, 84.*
Cicuta virosa, L.—*Not from 78, 82, 84.*
Carum Petroselinum, L.—An escape or casual, 78, 83, 84, 85, 86, 87.
—— Carui, L.—Escape or † near houses in 83, 84, 85, 86, 87.
Sison Amomum, L.—81, casual.
Falcaria vulgaris, Bernh.—87, casual.
Sium latifolium, L.—82 (? "Top. Bot."), 84 (S.), 85 (?), 86.
—— erectum, Huds.—*Not from 78, 79, 84, 86.*
Ægopodium Podagraria, L.—In every district. In north-east Scotland its distribution is very suggestive of its introduction by man, though now often abundant and apparently native.
Pimpinella major, Huds.—80 †, 83, 84 (S.), 85 (?), 86 (S.), 87 †. Requires revision.
—— Saxifraga, L.—In all.
Conopodium denudatum, Koch.—In all.
Myrrhis Odorata, Scop.—Often abundant by streams, but appears to be a relic of early cultivation.
Chærophyllum temulum, L.—In all.
—— aureum, L.—83 (S.), 86 (S.); can be only a casual.
Scandix Pecten-Veneris, L.—*Not from 78, 79, 87.* Is it more than a colonist?
Anthriscus vulgaris, L.—*Not from 78* (?), *79*, and with † in 80. Is it native?
—— sylvestris, Hoffm.—*Not from 80.*
—— Cerefolium, L.—Outcast or casual in 83.
Fœniculum vulgare, L.—Casual, 83.
Crithmum maritimum, L.—"Said to grow on islands in the Firth of Forth, but not now to be found," Greville, in "Fl. Edin." (1824).
Œnanthe fistulosa, L.—81, 85 (?) (not in F.E.).
—— pimpinelloides, L.—87 † (?).
—— Lachenalii, C. Gmel.—82.
—— Crocata, L.—*Not from 78, 79.*
—— Phellandrium, L.—81, 82, 83.

Æthusa Cynapium, L.—*Not from 84.* Only a colonist.
Silaus flavescens, Bernh.—80, 81, 82, 83, 85.
Meum Athamanticum, Jacq.—*Not from 79, 81*, and with † from 82.
Ligusticum scoticum, L.—81, 82, 83, 85.
Angelica sylvestris, L.—In all.
Archangelica officinalis, Hoffm.—85 †, 87 †.
Peucedanum palustre, Mœnch.—83, probably in error.
—— sativum, Benth. and Hook. f.—Casual in 85, 86, 87.
—— Ostruthium, L.—83 (S.), 85, 86, 87. No doubt † in all, though not so marked in 83, 85.
Heracleum Sphondylium, L.—In all.
Coriandrum sativum, L.—Casual, 83.
Daucus Carota, L.—*Not from 78.*
—— gummifer, Lam.—80 † (?).
Caucalis arvensis, Huds.—83 ("Canonmills; not now to be found," F.E., ? casual). 86 (S.), casual.
—— Anthriscus, Huds.—In all.
—— nodosa, Scop.—80, 81, 83, 85.
Cornus sanguinea, L.—*Not from 78, 79, 87.* Only as an introduced shrub.
Adoxa Moschatellina, L.—*Not from 78, 84*, and doubtfully from 85.
Sambucus nigra, L.—From all the counties, usually without query as native, yet very doubtful as such. *Var.* laciniata, L., where planted.
—— racemosa, L.—Often planted, and sometimes apt to spread.
—— Ebulus, L.—80, 81, 83, 84 (S.), 85, 86, usually given as native, but requires scrutiny as such.
Viburnum Opulus, L.—*Not from 78, 79, 84.* So frequently planted and easily dispersed that its being native is very doubtful.
—— Lantana, L.—81, 83, 85, 86. Almost certainly †.
Symphoricarpus racemosus, Michx.—Frequently introduced in shrubberies, and often looking almost naturalised.
Linnæa borealis, L.—81, 83.
Lonicera Caprifolium, L.—Given as native in 83, 84, and from "Linton" (? which), 85 (?), but certainly †.
—— Xylosteum, L.—† 82, 83.
—— alpina, L.—† Slateford.
—— Periclymenum, L.—In all.
Galium boreale, L.—*Not from 78, 79, 82, 83, 84.*
—— Cruciata, L.—In all.
—— verum, L.—In all.
—— erectum, Huds.—83 (?), 86.
—— Mollugo, L.—*Not from 78, 79, 85.*
—— saxatile, L.—In all.
—— sylvestre, Poll.—78, 80, 83, 86, 87.
—— palustre, L.—The varieties require to be looked for in Forth and Tweed.
—— uliginosum, L.—*Not from 82, 84.*
—— anglicum, Huds., has been recorded from 80, and G. Vaillantii, DC., from 83, but in error, or perhaps as casuals. The genus should receive attention in the district.
—— Aparine, L.—In all.
Asperula odorata, L.—*Not from 78.*
—— taurina, L.—† in 79, 81, 83, 85.
Sherardia arvensis, L.—In all.
Valeriana dioica, L.—*Not from 87.*
—— officinalis, L.—All the counties. Probably these records refer to sambucifolia, Willd., but it is not named. Mikanii, Syme, is named only for 86, in Ewing's "Glasgow Catalogue."

Valeriana pyrenaica, L.—Not rare as an introduction, 82, 83, 84, 85, 86, 87.
Centranthus ruber, DC.—Called "doubtful native," in 82, 83, 84 (S.), 85, and † in 87. No doubt †.
Valerianella olitoria, Poll.—*Not from 79*
—— eriocarpa, Desv.—84 (S.), 85.
—— rimosa, Bast.—85 (? colonist).
—— dentata, Poll.—*Not from 78, 79, 84, 86.*
Dipsacus sylvestris, Huds.—Pentland Hills (? which county), 81 †, 83, 85, 86 †, 87 (?). Is it not † in all?
—— pilosus, L.—† in 83, 85.
Scabiosa Succisa, L.—In all.
—— Columbaria, L.—80, 81, 82, 84 † (S.), 86, 87.
—— arvensis, L.—*Not from 78.*
Eupatorium cannabinum, L.—*Not from 78, 79, 84.*
Solidago Virgaurea, L.—*Not from 78*; but *var.* cambrica, Huds., is recorded from Pentland Hills.
Bellis perennis, L.—In all.
Aster Tripolium, L.—81, 82, 83, 85.
Erigeron acre, L.—80.
—— canadense, L.—Casual, in 86.
Filago germanica, L.—*Not from 84 or 78* (?), Linton.
—— minima, Fr.—*Not from 78.*
Antennaria dioica, R. Br.—*Not from 84.*
Gnaphalium uliginosum, L.—In all.
—— sylvaticum, L.—In all.
—— supinum, L.—86, 87.
Inula Helenium, L.—85 † (S.), 86 (?), in Ewing's "Glasgow Catalogue," but cannot be native.
Pulicaria dysenterica, Grtn.—81, 82, 84 (S.), 86.
Xanthium spinosum, L.—Casual in 86.
Bidens cernua, L.—80, 81, 83, 84, 85.
—— tripartita, L.—83, 84, 85, 86, 87.
Achillea Millefolium, L.—In all.
—— Ptarmica, L.—In all.
Anthemis tinctoria, L.—Casual, 85.
—— Cotula, L.—80, 82, 83, 85. Is this native?
—— arvensis, L.—*Not from 79.* Marked † in 86, and should probably be so more often than it is.
—— nobilis, L.—Escape or outcast; recorded from 79, 81.
Chrysanthemum segetum, L.—*Not from 78, 79.* A colonist only.
—— Leucanthemum, L.—In all.
—— Parthenium, L.—From every county (as native, except for 78), certainly †.
Matricaria inodora, L.—*Not from 80.* The forms never specified.
—— maritima, L.—81, 83, 85.
—— Chamomilla, L.—80, 83, 85, 86, 87. Is this native anywhere in Forth or Tweed?
—— discoidea, DC.—83, on railway embankments, etc.
Tanacetum vulgare, L.—*Not from 78, 84.* Its habitats cause great doubt as to its being native.
Artemisia Absinthium, L.—81, 82, 83, 84, (?) † in 85, 87, and probably should be so elsewhere.
—— vulgaris, L.—*Not from 78.* Chiefly near villages and by roads.
—— campestris, L.—† in 85, 86.
—— maritima, L.—81, 82, 85 (?) *Var.* gallica, Willd., 82.
Tussilago Farfara, L.—In all.
Petasites fragrans, Presl.—† in 81 (S.), 82, 83, 85.

Petasites officinalis, Mœnch.—In all.
—— albus, Gærtn.—† in 85, 86, 87.
Doronicum Pardalianches, L.—†, 82, 83, 85, 86, 87.
—— plantagineum, L.—†, 82, 83, 85.
Senecio vulgaris, L.—In all.
—— sylvaticus, L.—*Not from 84.*
—— viscosus, L.—*Not from 78, 80 (?), 82 (?), 84.*
—— erucifolius, L.—80, 81.
—— Jacobæa, L.—In all.
—— aquaticus, L.—In all.
—— saracenicus, L.—†, 82, 84, 85 (?), 86 (?).
Carlina vulgaris, L.—79, 81.
Arctium Lappa, L.—The aggregate is recorded from every county, but the forms have not been discriminated.
—— majus, Bernh.—(82, 84, 85) in F.E., 86 (?) Ewing's "Glasgow Catalogue."
—— nemorosum, Lej.—81, 83.
—— minus, Bernh.—*Not from 79, 80.*
—— intermedium, Lange.—82 (F.E.), 86.
Carduus pycnocephalus, L.—*Not from 78, 84,* with † from 79.
—— nutans, L.—*Not from 78, 84, 85* (?).
—— crispus.—*Not from 80.*
Cnicus lanceolatus, Willd.—In all.
—— eriophorus, Roth.—†, 83, 84, 85, 87.
—— palustris, Willd.—In all.
—— pratensis, Willd.—†, 84 (S.).
—— arvensis, Hoffm.—The varieties have not been recorded except from 87; and setosus, Bess., also from 84 (S.), 85, 86.
Onopordon Acanthium, L.—†, 80, 81, 82, 83, 85, 86.
Mariana lactea, Hill.—Given as native from 82, 83, 85, but certainly †.
Saussurea alpina, DC.—87.
Serratula tinctoria, L.—† in 87.
Centaurea montana, L.—† in 83.
—— nigra, L.—In all.
—— Scabiosa, L.—80, 82, 85, 86 †, 87 †.
—— Cyanus, L.—*Not from 79.* A colonist.
—— Calcitrapa, L.—A casual in 87.
Cichorium Intybus, L.—Recorded from 80, 81, 82, 83, 84, 85. No doubt † in all.
Picris hieracioides, L.—†, 80.
—— echioides, L.—80, 81, 82, 85, 87. No doubt casual or †.
Crepis taraxacifolia, Thuill.—†, 80.
—— virens, L.—In all.
—— biennis, L.—†, 80, 82, 86.
—— succisifolia, Tausch.—78, 80, 81, 83, 85 (?), 87.
—— paludosa, Mœnch.—In all.
Hieracium.—The older determinations of species in this genus are so uncertain, except for a few, that it seems useless to refer to them. In recent years several have been ascertained for 86 by Messrs. Stirling and Kidston, and some for 87 are enumerated in the "Flora of Perthshire." The genus, as a whole, requires revision for the rest of the district. A list of Scottish Hieracia, with their distribution by counties, as far as known to me up to 1902, is contained in "Annals of Scot. Nat. Hist.," 1902, pp. 244–250.
Hypochæris glabra, L.—87.
—— radicata, L.—In all.
Leontodon hirtus, L.—80, 82, 83, 85.

Leontodon hispidus, L.—*Not from 84, 86.*
—— autumnalis, L.—*Var.* pratensis, Koch., is recorded from 86 only.
Taraxacum officinale, Web.—*Var.* erythrospermum, Andrz., only from 83, 85. *Var.* palustre, DC., *not from 79, 84. Var.* udum Jord., not recorded.
Lactuca virosa, L.—81, 82 † (S.), 83, 85, 86, 87.
—— muralis, Fresen.—†, 83, 86, 87.
Sonchus oleraceus, L.—In all.
—— asper, Hoffm.— Not from 80, 84.
—— arvensis, L.—In all.
—— palustris, L.—"Lochend." Not found there of late. F.E., ? error.
Tragopogon pratense, L.—*Not from 78, 79, 84. Var.* minus, Mill. 82, 83, 85.
Lobelia Dortmanna, L.—85, 86, 87.
Jasione montana, L.—79, 85 (?).
Campanula glomerata, L.—82, 85.
—— Trachelium, L.—82, 83, 85, 86. Is this native ?
—— latifolia, L.—*Not from 78, 84.*
—— rapunculoides, L.—†, 82, 83, 85.
—— rotundifolia, L.—In all. The varieties have not been recorded.
—— persicifolia, L.—†, 83, 84 (S.).
—— Rapunculus, L.—†, 85, 86 (S.).
—— patula, L.—†, 82, 83 (S.).
Specularia hybrida, A. DC.—Casual in 82, 85, 86.
Vaccinium Vitis-idæa, L.—*Not from 82, 84.*
—— uliginosum, L.—87.
—— Myrtillus, L.—In all.
Schollera Occycoccus, Roth.—*Not from 82, 84.*
Arctostaphylos Uva-ursi, L.—78, 81.
Andromeda Polifolia, L.—80, 86, 87.
Calluna Erica, DC.—In all.
Erica cinerea, L.—In all.
—— Tetralix, L.—In all.
Loisleuria procumbens, Desv.—85 (?), 86.
Ledum palustre, L.—86, 87, probably †.
Pyrola rotundifolia, L.—Recorded from 78, 80, 81, 83, 85, 87, but much needs revision.
—— media, Sw.—80, 81, 82, 83 (S.), 85, 87.
—— minor, L.—*Not from 78, 81, 82.*
—— secunda, L.—84 † (S.), 86 † (S.), 87.
Statice Limonium, L.—85 (?).
Armeria maritima, Willd.—81, 82, 83, 85, 86.
Primula acaulis, L.—*Not from 78. Var.* caulescens, Koch., 82, 83, 85.
—— veris, L.—*Not from 78, 79.* ? † in 87.
—— farinosa, L.—78.
Lysimachia thyrsiflora, Ait.—83, 84, 86, 87. Is this native in all these ?
—— vulgaris, L.—Doubtful native. 81 (? extinct), 83, 84, 85, 86, 87.
—— Nummularia, L.—†, *not from 82, 84.*
—— nemorum, L.—In all.
Trientalis europæa, L.—*Not from 78, 80, 82, 84.*
Glaux maritima, L.—*Not from 78, 79, 80, 84.*
Anagallis arvensis, L.—*Not from 78, 79.*
—— cærulea, Schreb.—82.
—— tenella, L.—81, 82, 83, 84, 85.
Centunculus minimus, L.—81, 85, 87.
Samolus Valerandi, L.—81, 82, 84, 85, 86 (Ewing's "Gl. Cat.").

Fraxinus excelsior, L.—Frequent in all counties, and possibly native as well as planted.
Ligustrum vulgare, L.—†, *not from 78, 79, 82.*
Vinca major. L.—†. in 82, 83, 85.
—— minor, L.—*Not from 78. 79, 80, 87,* † though often appearing to be native.
Erythræa Centaurium, L.—*Not from 79 and* (?) *78* (Linton).
—— littoralis, Fr.—82.
—— pulchella, Fr.—82.
Gentiana Amarella, L.—80, 81, 82, 83, 85 (?), 86.
—— campestris, L.—*The aggregate not from 84.* The forms now separated (G. campestris, seg., and G. baltica, Murbeck), have not been distinguished in the records from Forth or Tweed.
—— acaulis, L.—Occurs, as an escape, in 83.
Limnanthemum peltatum, C. Gmel.—81. Probably introduced intentionally.
Polemonium cæruleum, L.—81, 82, 83, 84, 85, 86, 87. A denizen or casual.
Cynoglossum officinale, L.—81, 82, 83, 84, 85.
Asperugo procumbens, L.—Casual in 82, 83, 84 (S.), 85.
Symphytum officinale, L.—*Not from 78, 82.* A doubtful native.
—— tuberosum, L.—*Not from 78, 80.*
—— asperrimum, Donn.—†, 83, 85.
Borago officinalis, L.—Casual or †, 82, 83, 85, 86.
Anchusa sempervirens, L.—†, 82, 83, 85.
—— officinalis, L.—83, 86 (S.), casual or outcast.
Lycopsis arvensis, L.—From all counties; a colonist.
Pulmonaria officinalis, L.—†, 83, 85.
Pneumaria maritima, Hill.—81, 82, 85.
Myosotis palustris, Relh., *var.* strigulosa, Mart. and Koch.—83, 86.
—— repens, G. Don.—*Not from 82, 84.*
—— sylvatica, Hoffm.—79, 80, 81, 83, 86, 87, casual. Not usually marked as "doubtful native." Its claim to be native requires confirmation. It is often an escape or outcast.
—— arvensis, Lam.—In all.
—— collina, Hoffm.—*Not from 78, 79, 80.*
—— versicolor, Reichb.—In all.
Omphalodes verna, Mœnch.—Escape or planted, 83, 84 (S.).
Lithospermum officinale, L.—82, 83, 85, 87 †. Doubtful as a native plant.
—— arvense, L.—*Not from 79, 87.* Spread by agriculture, if not †.
—— purpureo-cœruleum, L.—†, 86.
Echium vulgare, L.—Not from 78, 79.
Volvulus sepium, Junger.—81, 82, 83, 85, 86, 87. Often, if not usually, an escape.
—— Soldanella, Junger.—82, 87.
Convolvulus arvensis, L.—*Not from 78, 79, 80, 84.*
Cuscuta Epilinum, Weihe.—Casual, 82 (S.), 83.
—— europæa, L.—80 (?) †, 83 (?).
—— Epithymum, Murr.—83 (?), 85 (?), 86.
—— Trifolii, Bab.—†, 82, 83.
Solanum Dulcamara, L.—*Not from 78, 79, 84.*
—— nigrum, L.—*Not from 78, 79, 82,* † or casual.
Lycium chinense, Mill.—†, 85.
Atropa Belladonna, L.—†, 81, 82, 83, 85, 86, 87.
Hyoscyamus niger, L.—80, 81, 82, 83, 85, 86. Is this native here?
Verbascum Thapsus, L.—*Not from 79, 80.* Marked † for 85, and probably should be so in other counties.

Verbascum pulverulentum, Vill.—†, 84.
—— Lychnitis, L.—†, 85, 86.
—— nigrum, L.—†, 81, 82, 83, 85, 86.
Linaria Cymbalaria, L.—82, 83. 85, 86. 87, † in Scotland, though not marked as such in local floras.
—— Elatina, Mill.—86.
—— repens, Mill.—†, 83, 86, 87.
—— vulgaris, Mill.—In all. Is it native?
—— viscida, Mœnch.—80, 81, 85 †, 86 †.
Antirrhinum majus, L.—†, 83, 85.
Scrophularia aquatica, L.—81, 83, 84 (?), 85, 87. In need of revision.
—— umbrosa, Dum.—80, 81, 83, 84, 85.
—— vernalis, L.—†, 82, 83, 85, 86, 87. Seldom noted as not native.
Mimulus Langsdorffii, Donn.—†, 82, 83, 85, 86, 87. (Very frequent in north-east Scotland.)
Limosella aquatica, L.—82.
Veronica hederifolia, L.—(? colonist). *Not from 78.*
—— polita, Fr.—(? colonist). *Not from 79.*
—— agrestis, L.—(? colonist). In all.
—— Tournefortii, C. Gmel.—*Not from 79*; a colonist.
—— fruticulosa, L.—†, 83.
—— serpyllifolia, L., in all; *var.* humifusa, Dickson.—87.
—— alpina, L.—86 (?), 87 (?).
—— Chamædrys, L.—In all.
—— montana, L.—*Not from 78, 84, 85* (?).
—— Anagallis-aquatica, L.—*Not from 84.*
—— Beccabunga, L.—In all.
Euphrasia officinalis, L.—The aggregate is recorded from every county, but of the segregates only E. brevipila, Burn. and Gr., 87, and E. gracilis, Fr., 86, are recorded from Forth and Tweed.
Bartsia Odontites, Huds.—Recorded from all the counties, but the varieties not distinguished.
—— viscosa, L.—85, 86.
—— alpina, L.—85 (?).
Pedicularis palustris. L.—In all.
—— sylvatica, L.—In all.
Rhinanthus Crista-galli, L.—In all. *Var.* Drummond-Hayi, F. B. White, 87.
—— major, Ehrh.—81, 85 (? colonist). The varieties under both species should be wrought out.
Melampyrum pratense, L.—*Not from 78.* The varieties require to be studied here, only montanum, Johnst., from 87, being yet recorded from Forth or Tweed.
—— sylvaticum, L.—80, 81, 83 (?), 87.
Orobanche major, L.—Sibbald records what may be this, under this name, as "Upon the Buck of Burntisland," but it has not been found in Fife by others.
—— rubra, Sm.—85.
—— minor, Sm.—85 (Syme, in "Top. Bot.").
Lathræa squamaria, L.—79, 80, 81, 83, 86, 87.
Utricularia vulgaris, L.—*Not from 78, 84, 86, 87.*
—— neglecta, Lehm.—79, 80.
—— minor, L.—Pentland Hills (? which county), 81, 83, 85, 86, 87.
—— intermedia, Hayne.—81, 85, 87.
Pinguicula vulgaris, L.—In all.
—— lusitanica, L.—86 (Ewing's "Gl. Cat.").
Verbena officinalis, L.—†, 85.
Mentha rotundifolia, Huds.—†, 83, 85.

Mentha alopecuroides, Hull.—†, 86.
—— longifolia, Huds.—81, 82, 83, 85 (?).
—— viridis, L.—†, 83, 85 (S.), 87.
—— piperita, L.—Is this anywhere native here? 79, 80, 81, 83, 85, 86.
—— hirsuta, L.—In all.
—— sativa, L.—*Not from 78, 79.*
—— rubra, Sm.—83, (?) †.
—— pratensis, Sole.—83 (?).
—— arvensis, L.—In all.
—— Pulegium, L.—Pentland Hills (? which county), 81, 83, 85. Is this native anywhere here?
Lycopus europæus, L.—78, 80, 82 (S.), 83 (S.), 84, 85, 86, 87.
Origanum vulgare, L.—*Not from 78.*
Thymus serpyllum, L—In all.
—— Chamædrys, Fr.—78, 82.
Calamintha Clinopodium, Benth.—*Not from 78.*
—— arvensis, Lam.—80, 81, 82, 83, 85.
—— officinalis, Mœnch.—87 (?).
Salvia Verbenaca, L.—81, 83, 85, 86.
Nepeta Cataria, L.—81, 85 (?), 86, 87, probably †.
—— Glechoma, Benth.—*Not from 78, 87.*
Scutellaria galericulata, L.—*Not from 78, 85* (?).
—— minor, Huds.—86.
Prunella vulgaris, L.—In all.
Marrubium vulgare, L—80, 81, 82, 83, 85, 87 casual. Probably not native.
Stachys Betonica, Benth.—80, 81, 83, 84 (?), 85.
—— palustris, L.—In all.
—— ambigua, Sm.—(palustris × sylvatica), Pentland Hills, 80, 81 (?), 82, 83, 87.
—— sylvatica, L.—In all.
—— arvensis, L.—*Not from 78, 79, 86.*
Galeopsis Ladanum, L.—The aggregate from 80 †, 82, 83, 85, 86.
—— versicolor, Curt.—A colonist. *Not from 82, 84.*
—— Tetrahit, L.—From all counties; a colonist.
Leonurus cardiaca, L.—†, 83, 85.
Lamium intermedium, Fr.—*Not from 79, 81, 84, 86.* Colonist; like L. amplexicaule, L., and L. purpureum, L., which occur in every county.
—— hybridum, Vill.—A colonist. *Not from 79, 82.*
—— maculatum, L.—†, 83, 84, 85, 86, 87.
—— album, L.—Probably a denizen, in every county.
—— Galeobdolon, Crantz.—†, 82, 83, 85, 86.
Ballota nigra, L.—80, 81, 82 (?) †, 83, 85 (?), 86, 87 casual. *Var.* fœtida, Koch., 82, 83, 85, 87 casual.
Teucrium Chamædrys, L.—†, 83.
—— Scorodonia, L.—In all.
Ajuga reptans, L.—In all.
Plantago major, L.—In all.
—— media, L.—*Not from 78, 79, 84.*
—— lanceolata, L.—In all.
—— maritima, L.—81, 82, 83, 85, 87.
—— Coronopus, L.—*Not from 78, 79, 80, 86.* The varieties of Plantago should be looked for in Forth and in Tweed.
Littorella juncea, Berg.—*Not from 78.*
Herniaria glabra, L.—81, probably in error.
Scleranthus annuus, L.—In all.
Chenopodium polyspermum, L.—81.

Chenopodium Vulvaria, L.—82, 83, 85 (?) †.
—— album, L.—From all. *Var.* incanum, Moq., 78.
—— murale, L.—80 (?).
—— hybridum, L.—†, 82 (S.), 83, 84 (S.), 85 (S.).
—— urbicum, L.—81 (?), 83 (?), 85 (?).
—— rubrum, L.—81, 83 (?), 85, 87 †.
—— botryodes, Sm.—85 (?).
—— glaucum, L.—†, 85.
—— Bonus-Henricus, L.—In every county, but a doubtful native.
Beta maritima, L.—82, 83, 84, 85, 86 (S.), 87, seashore. In how far native?
Atriplex littoralis, L.—81, 82, 83 (?), 84 (?), 85, 87.
—— patula, L.—*Not from 79, 80. Var.* erecta, Huds., *not from 79, 80, 87. Var.* angustifolia (Sm.), *not from 79, 80, 84.*
—— hastata, L.—*Not from 78, 79, 84.*
—— deltoidea, Bab.—80 †, 81, 83, 86.
—— Babingtonii, Woods.—81, 82, 83, 84, 85, 87.
—— laciniata, L.—83, 85, 87.
—— portulacoides, L.—83 (?), 85 (?).
Salicornia herbacea, L.—82, 83 (?), 85, 87.
Suæda maritima, Dum.—82, 83 (?), 84 (?), 85, 87.
Salsola Kali, L.—81, 82, 83, 84, 85, 87.
Polygonum Convolvulus, L.—In all.
—— aviculare, L.—In all. *Vars.* agrestinum, Jord.; vulgatum, Syme; rurivagum, Jord., all from 87, and littorale, Link., 82, 83, 85.
—— Raii, Bab.—82, 83, 85, 87.
—— Hydropiper, L.—*Not in 78.*
—— minus, Huds.—85 (?), 87.
—— mite, Schranck.—86.
—— Persicaria, L.—In all.
—— lapathifolium, L.—*Not from 79, 84.*
—— maculatum, Trim and Dyer.—85, 87.
—— amphibium, L.—In all.
—— Bistorta, L.—79, 80, 82, 83, 84, 85, 86, 87. ? native in any.
—— viviparum, L.—85, 86, 87.
Fagopyrum esculentum, Mœnch.—Casual in 82, 83, 85.
Oxyria digyna, Hill.—86, 87.
Rumex conglomeratus, Murr.—*Not from 79.*
—— sanguineus, L.—*Not from 79, 86. Var.* viridis, Sibth., 82, 83, 85, 86, 87.
—— maritimus, L.—81 †, 85 (?), 86 casual, 87.
—— limosus, Thuill.—82 (?).
—— pulcher, L.—80, casual.
—— obtusifolius, L.—In all.
—— crispus, L.—In all.
—— domesticus, Hartm.—*Not from 82*; crispus × obtusifolius (acutus, L.), 78, 80, 81, 83, 85, 86, 87; domesticus × obtusifolius (conspersus, Hartm.), 78, 80, 81, 85, 87.
—— Hydrolapathum, Huds.—80, 81, 85.
—— alpinus, L.—†, 83, 85, 86, 87.
—— Acetosa, L.—In all.
—— scutatus, L.—†, 83, 85.
—— Acetosella, L.—In all.
Asarum europæum, L.—†, 83, 84, 85.
Daphne Mezereum, L.—† 83, 85.
—— Laureola, L.—†, 81, 83, 85, 86, 87.
Hippophaë rhamnoides, L.—†, 82, 83, 84, 85.
Euphorbia Helioscopia, L.—From all counties, but only a colonist.

Euphorbia dulcis.—87 casual.
—— Esula, L.—†, 82, 83, 84, 85.
—— Cyparissias, L.—†, 83, 85.
—— Paralias, L.—†, 85.
—— portlandica, L.—†, 84, 85.
—— Peplus, L.—A colonist. *Not from 78.*
—— exigua, L.—A colonist. *Not from 78, 79, 86.*
—— Lathyris, L.—†, 85.
—— purpurata, Thuill.—†, 87.
Buxus sempervirens, L.—†, 83, 85.
Mercurialis annua, L.—82, 83, 85, 86, 87. Often a mere casual.
—— perennis, L.—In all.
Ulmus montana, L.—*Not from 80*, often planted.
—— surculosa, Stokes.—†, 80, 81, 83, 86. *Var.* suberosa, Ehrh., 81, 83, 87.
Humulus Lupulus, L.—† *Not from 78, 79, 82, 84.*
Parietaria officinalis, L.—*Not from 80, 84.* In how far is this native in Forth and Tweed?
Myrica Gale, L.—Pentland Hills (in which county?), 79, 83, 84, 85, 86, 87.
Betula alba, L.—The aggregate in all.
—— verrucosa, Ehrh.—78, 83, 85 †, 86, 87.
—— pubescens, Ehrh.—78, 80, 83, 85, 86, 87.
—— nana, L.—78, 81 (?).
Alnus glutinosa, L.—From all.
Carpinus Betulus, L.—†, 78, 81, 83, 85, 86, 87.
Quercus Robur, L.—From all. *Var.* pedunculata (Ehrh.). Not from 79, 81. In how many counties truly native? *Var.* sessiliflora (Salisb.), 78, 81, 83, 85†, 86, 87.
Castanea sativa, Mill.—†, 83, 84, 85, 86.
Fagus silvatica, L.—*Not from 79.* Usually planted, though often self-sown.
Salix triandra, L.—80, 81, 83, 87.
—— pentandra, L.—From all counties *except 78* (?)
—— fragilis, L.—From all counties. How far is it native? *Var.* britannica, F. B. White, 80, 83, 87.
—— alba, L.—*Not from 82.* Almost certainly planted in most places. *Var.* vitellina, L., 80.
—— cinerea, L.—In all.
—— aurita, L.—*Not from 82.*
—— Caprea, L.—In all.
—— repens, L.—*Not from 82*, 78 (?).
—— phylicifolia, L.—*Not from 82, 84*, 78 (?), 85 (?).
—— nigricans, Sm.—78, 80, 81, 83, 86, 87.
—— viminalis, L.—*Not from 79, 82*, 78? Very often †.
—— Lapponum, L.—83, 86, 87.
—— herbacea, L.—86, 87.
—— reticulata, L.—87.
—— purpurea, L.—*Not from 82, 85.* Often planted.
—— alba × fragilis.—80, 83, 84 (?) 85 (?).
—— aurita × cinerea.—80, 86 (?).
—— aurita × Lapponum.—83.
—— aurita × repens (ambigua, Ehrh.).—80, 81.
—— Caprea × cinerea.—85.
—— Caprea × nigricans.—83.
—— Capreæ × viminalis forms,—(acuminata, Sm.).—81, 83; (ferruginea, G. And.), *not from 78, 82, 87*; (Smithiana, Willd.), 33, 84, 85, 86 (?); (stipularis, Sm.), 80.

Salix cinerea × Lapponum.—83.
—— fragilis × triandra.—80, 85, 86.
—— purpurea × viminalis.—78, 80, 81, 83, 84 (?), 86. Occasionally planted.
—— triandra × viminalis.—80, 81.
Populus alba, L.—†, 83, 84, 85, 86, 87.
—— canescens, Sm.—†, 78, 80, 81.
—— tremula, L.—*Not from 82, 84.*
—— nigra, L.—†, 83, 84, 86, 87.
Empetrum nigrum, L.—*Not from 84.*
Ceratophyllum aquaticum, agg.—81, 83, 84, 85 (?), 86. The segregates are recorded thus—
—— demersum, L.—83, 84, 85 (?), 86.
—— submersum, L.—84, 85 (S.).

## MONOCOTYLEDONS.

Elodea canadensis, Michx.—†, 83, 84, 85, 86, 87.
Stratiotes Aloides, L.—†, 83, 84 (S.).
Malaxis paludosa, Sw.—85, 86, 87.
Corallorhiza innata, R. Br.—81, 83, 85, 87.
Neottia Nidus-avis, L.—*Not from 78.*
Listera cordata, R. Br.—Pentland Hills (in which county ? ). *Not from 78 (?), 84.*
—— ovata, R. Br.—Pentland Hills (? 78), and all other counties.
Goodyera repens, R. Br.—80, 81, 84, 85.
Cephalanthera ensifolia, Rich.—83, 85.
Epipactis latifolia, All.—*Not from 78, 79.*
—— violacea, Bor.—84 (?).
—— palustris, Crantz.—81, 82, 83 (?), 85, 87.
Orchis pyramidalis, L.—81, 85.
—— Morio, L.—83, in error.
—— mascula, L.—*Not from 78.*
—— latifolia, L.—agg. From all counties.
—— incarnata, L.—*Not from 78, 81, 83, 85 (?).*
—— latifolia, L.—seg. *Not from 78, 80, 81, 87.*
—— maculata, L.—*Not from 80.*
Habenaria Conopsea, Benth.—*Not from 78, 82.*
—— albida, R. Br.—85, 86, 87.
—— viridis, R. Br.—*Not from 78, 80.*
—— bifolia, R. Br.—*Not from 78, 79.*
—— chloroleuca, Ridley.—*Not from 78.*
Iris fœtidissima, L.—†, 83, 85, 87.
Crocus aureus, Sibth.—†, 83.
Narcissus Pseudo-narcissus, L.—†, 81, 83, 85, 86, 87.
—— poeticus, L.—†, 82.
Galanthus nivalis, L.—†, 83, 85, 86, 87.
Ruscus aculeatus, L.—†, 83, 85.
Asparagus officinalis, L.—†, 82.
Polygonatum multiflorum, Alb.—†, 82, 83, 85, 86, 87.
Maianthemum Convallaria, Weber.—†, 84.
Convallaria majalis, L.—†, 82, 83, 85, 86, 87.
Allium Scorodoprasum, L.—81, 85.
—— vineale, L.—*Not from 78, 80, 82, 86 (?), 87.*
—— oleraceum, L.—81, 85.
—— paradoxum, Don.—†, 83, 84.
—— Schœnoprasum, L.—†, 81, 83, 85.
—— ursinum, L.—*Not in 78.*

Scilla verna, L.—81.
Ornithogalum umbellatum, L.—†, 83, 85, 86.
—— nutans, L.—Escape in 83.
Lilium Martagon, L.—Escape in 83.
Tulipa sylvestris, L.—†, 83, 84, 85.
Gagea fascicularis, Salisb.—80, 83, 84, 85 (?), 86.
Colchicum autumnale, L.—†, 83, 87 (S.)
Narthecium Ossifragum, L.—*Not from 82*, 78 (?).
Tofieldia palustris, Huds.—86, 87.
Paris quadrifolia, L.—83, 85, 86, 87.
Juncus bufonius, L.—In all.
—— squarrosus, L.—In all.
—— compressus, Jacq.—80, 83, 84. All much need confirmation.
—— Gerardi, Loisel.—*Not from 78, 79, 80*, *i e.* occurs in all not purely inland counties.
—— tenuis, Willd.—(?), † 86.
—— balticus, Wild.—85, (? in Forth basin).
—— glaucus, Leers.—In all.
—— effusus × glaucus (= diffusus, Hoppe.), 85 (?), 87.
—— effusus, L.—In all.
—— conglomeratus, L.—In all.
—— maritimus, Lam.—84 (S.), 85 (?), 86 (S.)
—— supinus, Mœnch.—*Not from 79, 80.* The varieties have not been recorded here.
—— obtusiflorus, Ehrh.—82, 83 (?), 84 (?).
—— lampocarpus, Ehrh.—*Not from 80.*
—— acutiflorus, Ehrh.—*Not from 80.*
—— castaneus, Sm.—87.
—— biglumis, L.—86 (?), 87.
—— triglumis, L.—86, 87.
Luzula vernalis, DC.—*Not from 78, 79.*
—— maxima, DC.—In all.
—— nivea, DC.—†, 83, 85.
—— spicata, DC.—86, 87.
—— campestris, DC.—*Not from 79.*
—— erecta, Desv.—From all counties. *Var.* congesta alone is specially named, for 83, 84, 85, 86, 87.
Typha latifolia, L.—*Not from 78.* Certainly † in most, possibly in all the counties.
—— angustifolia, L.—83 (?), 85, 86.
Sparganium ramosum, L.—In all.
—— simplex, Huds.—*Not from 78, 82, 84.*
—— affine, Schnizl.—*Not from 78.*
—— minimum, Fr.—79, 83, 86, 87.
Arum maculatum, L.—79, 80, 81, 83, 84, 85 †, 86, 87 †. Probably † in several counties.
Acorus Calamus, L.—†, 86.
Lemna trisulca, L.—80, 81, 82 (?), 83, 85, 86.
—— minor, L.—*Not from 78.*
—— gibba, L.—83, 84 (?), 85 (?), 86.
—— polyrrhiza, L.—83, 84 (?).
Wolffia Michelii, Schleid.—Introduced, in 1870, into 83.
Alisma Plantago-aquatica, L.—*Not from 78.*
—— ranunculoides, L.—*Not from 78, 79, 84, 86.* *Var.* repens, Davies, 87.
Sagittaria sagittifolia, L.—†, 86.
Butomus umbellatus, L.—†, 83, 84 (S.), 87.
Triglochin palustre, L.—In all.

Triglochin maritimum, L.—*Not from 78, 79, 80 (inland counties).*
Potamogeton natans, L., seg. *Not from 86.*
—— polygonifolius, Pour.—In all. *Var.* pseudofluitans, Syme, 86.
—— coloratus, Hornem.—79, 80, 81, 82.
—— alpinus, Balb.—*Not from 79, 80, 84* (?).
—— heterophyllus, Schreb.—*Not from 80, 82, 83* (?), *84.*
—— nitens, Weber.—80, 85, 86.
—— lucens, L.—*Not from 78, 82, 84.*
—— decipiens, Nolte.—80, 81, 86.
—— angustifolius, Presl. (=P. Zizii, Roth.)—79, 80, 81, 86, 87.
—— prælongus, Wulf.—*Not from 78, 82, 83* (?), *84, 87.*
—— perfoliatus, L.—*Not from 78, 82.*
—— crispus, L.—Type reported from all but 87 (?). *Var.* serratus, Huds., 87.
—— densus, L.—80, 82, 83.
—— zosteræfolius, Schum.—85 (?), 86 (?).
—— obtusifolius, Mert. and Koch.—*Not from 78, 82, 83* (?), *84. Var.* fluvialis, Lange and Mort., 87.
—— Friesii, Rupr.—79 (?), 85, 86.
—— pusillus, L.—*Not from 78.*
—— Sturrockii, Ar. Benn.—86.
—— pectinatus, L.—*Not from 78, 79, 82.*
—— interruptus, Kit.—80, 81, 83.
—— filiformis, Nolte.—81, 83, 85.
Ruppia rostellata, Koch.—82.
Zannichellia palustris, L.—*Not from 78, 84, 85* (?).
—— pedunculata, Reichb.—87 (?).
Zostera marina, L.—82, 83, 85.
Eleocharis acicularis, R. Br.—78, 83, 85, 86, 87.
—— palustris, R. Br.—In all.
—— uniglumis, Reichb.—82, 84, 85.
—— multicaulis, Sm.—*Not from 80, 82*, 78 (?) (Pentland Hills).
Scirpus pauciflorus, Lightf.—From all except 78 (?) (Pentland Hills).
—— cæspitosus, L.—*Not from 82.*
—— fluitans, L.—81, 83, 85, 86, 87 (?).
—— setaceus, L.—In all.
—— lacustris, L.—*Not from 78, 84.*
—— Tabernæmontani, Gmel.—82, 85, 87.
—— maritimus, L.—*Not from 78, 79, 80.*
—— sylvaticus, L.—*Not from 82, 84.*
—— Caricis, Retz.—79, 80, 81, 82, 83.
—— rufus, Schrad.—*Not from 78, 79, 80.*
Eriophorum vaginatum, L.—In all.
—— angustifolium, Roth.—In all.
—— latifolium, Hoppe.—(Pentland Hills), 81, 83, 87.
Rhynchospora alba, Vahl.—86, 87,
Schœnus nigricans, L.—81, 85, 86 (?).
Cladium jamaicense, Crantz.—81.
Carex dioica, L.—*Not from 78, 82.*
—— pulicaris, L.—*Not from 78, 82.*
—— pauciflora, Lightf.—85, 86, 87.
—— incurva, Lightf.—82 (?), 83 (?), 84 (?), 85, 86 (S.) (?).
—— divisa, Huds.—83, in error.
—— disticha, Huds.—*Not from 78* (?) (Pentland Hills).
—— arenaria, L.—81, 82, 83, 85, 86 (?).
—— teretiuscula.—*Not from 78* (?) (Pentland Hills). *Var.* Ehrhartiana, Hoppe, 86.
—— paniculata, L.—*Not from 78* (?) (Pentland Hills).

Carex vulpina, L.—*Not from inland counties, 78, 79, 80.*
—— muricata, L.—*Not from 78* (?) (Pentland Hills).
—— divulsa, Good.—83 (?).
—— remota, L.—*Not from 78, 82, 84, 85.*
—— axillaris, Good.—83 (?).
—— Bœninghausiana, Weihe.—83.
—— curta, Good.—*Not from 78* (?) (Pentland Hills).
—— ovalis, Good.—In all.
—— atrata, L.—86.
—— Hudsonii, Ar. Benn.—83 (?), 84 (?), 85 (?).
—— acuta, L.—80, 81, 83 (?), 84 (?), 85 (?), 86. *Var.* gracilescens, Almq., 86.
—— rigida, Good.—78, 80, 86, 87.
—— aquatilis, Wahlenb. (as *var.* elatior, Bab.).—*Not from 82, 83.*
—— Goodenovii, J. Gay.—In all. *Var.* juncella, T. M. Fries., 86.
—— flacca, Schreb.—In all.
—— limosa, L., agg.—*Not from 78, 79, 82, 83* (?).
—— magellanica, Lam.—83 (S.), 85, 86, 87.
—— limosa, L., seg.—80, 81, 84, 85, 87.
—— pilulifera, L.—*Not from 82, 84.*
—— verna, Chaix.—In all.
—— pallescens, L.—*Not from 80, 82, 84.*
—— panicea, L.—In all.
—— vaginata, Tausch.—86.
—— capillaris, L.—87.
—— pendula, Huds.—81, 82, 83, 86, 87.
—— strigosa, Huds.—83 (?).
—— sylvatica, L.—*Not from 78, 84.*
—— lævigata, Sm.—*Not from 80, 82, 84, 87.*
—— binervis, Sm.—*Not from 84.*
—— distans, L.—81 (?), 82, 83 (?), 84 (S.), 85, 86.
—— fulva, Good.—*Not from 82,* 78 (?) (Pentland Hills).
—— extensa, Good.—81, 82, 83 (?), 85.
—— flava, L., agg.—In all. The forms require to be wrought out in light of more recent views.
—— filiformis, L.—79, 80, 81, 83.
—— acutiformis, Ehrh. (paludosa, Good.).—*Not from 84, 85* (?).
—— riparia, Curtis.—81, 82, 83, 85, 86, 87.
—— rostrata, Stokes (ampullacea, Good.).—From all *except 78* (?) (Pentland Hills).
—— vesicaria, L.—*Not from 82, 84,* 78 (?) (Pentland Hills).
—— pulla, Good.—86 (?), 87.
Setaria viridis, Beauv.—Casual, 80, 85.
Phalaris canariensis. L.—Casual, 83, 85, 86, 87.
—— arundinacea, L.—In all.
Anthoxanthum odoratum. L.—In all.
—— Puellii, Lecoq. and Lamotte.—Casual, 80.
Alopecurus myosuroides, Huds.—78, 82 †, 85 †, 86, 87, casual. A doubtful native in any.
—— fulvus, Sm.—†, 85, 86 (S.).
—— geniculatus, L.—In all.
—— pratensis, L.—In all.
Stipa capillata.—86 (S.), casual.
Milium effusum, L.—*Not from 78, 82.*
Phleum pratense, L.—In all.
—— arenarium, L.—82, 83, 85, 86.
Mibora verna, Beauv.—Casual, 82, 86.
Agrostis canina, L.—*Not from 81.*

Agrostis palustris, Huds.—*Not from 80.* *Var.* stolonifera, L., 86.
—— vulgaris, L.—In all. *Var.* pumila, L., 78 (?) (Pentland Hills) 82, 83, 85, 86, 87. *Var.* nigra, With., 87.
Polypogon monspeliensis, Desf.—Casual, 80, 85, 86.
—— littoralis, Sm.—Casual, 80, 85.
Calamagrostis epigeios, Roth.—80 (?), 85 †, 86.
—— lanceolata, Roth.—83 (?).
Gastridium australe, Beauv.—Casual, 80.
Apera Spica-venti, Beauv.—†, 83, 86.
—— interrupta, Beauv.—Casual, 83.
Ammophila arundinacea, Host.—*Not from 78, 79, 80, 84.*
Lagurus ovatus, L.—Casual in 87.
Aira caryophyllea, L.—In all.
—— præcox, L.—In all.
Deschampsia cæspitosa, Beauv.—From all counties. *Var.* pseudo-alpina, Syme, 86.
—— alpina, R. and S.—86.
—— flexuosa, Trin.—*Not from 82.* *Var.* montana, Hook. f., 86, 87.
(—— discolor, R. and S.—Ought to occur in the district, though not yet recorded.)
Holcus mollis, L.—In all.
—— lanatus, L.—In all.
Trisetum pratense, Pers. (Avena flavescens, L.).—In all.
Avena pubescens, Huds.—*Not from 78, 79, 82.*
—— pratensis, L.—*Not from 78, 82, 84.* *Var.* alpina, Sm., 87. *Var.* longifolia, Parn., 85 (?).
—— strigosa, Schreb.—Colonist or casual.
—— fatua, L.—†, *not from 78, 79, 84, 86.*
Arrhenatherum avenaceum, Beauv.—From all counties. *Var.* nodosum, Reichb., is the commoner form, though specially noted only from 86, 87.
Sieglingia decumbens, Bernh.—In all.
Phragmites communis, Trin.—In all.
Sesleria cœrulea, Ard.—86.
Cynosurus cristatus, L.—In all.
—— echinatus, L.—Casual, 83.
Kœleria cristata, Pers.—*Not from 78, 84.*
Molinia varia, Schranck.—From all counties. *Var.* depauperata, Lindl., 83, 85, 87.
Catabrosa aquatica, Beauv.—*Not from 78, 79, 80, 84.*
Melica nutans, L.—80, 81, 83, 84, 86, 87.
—— uniflora, Retz.—*Not from 78, 82.*
Dactylis glomerata, L.—In all
Poa annua, L.—In all.
—— alpina, L.—83 (S.), 86, 87.
—— glauca, Sm.—86, 87.
—— Balfourii, Parn.—87.
—— nemoralis, L.—*Not from 81, 82, 84, 85* (?).
—— compressa, L.—80, 81, 83, 85 (?), 86.
—— Chaixii, Vill.—Casual, 80.
—— pratensis, L.—In all. *Var.* subcœrulea, Sm., 84.
—— trivialis, L.—In all.
Glyceria fluitans, L.—In all.
—— plicata, Fr.—*Not from 78, 79, 83, 87.*
—— aquatica, Sm.—83, 84, 85, 86, 87.
—— maritima, Mert. and Koch.—*Not from the inland counties 78, 79, 80.*
—— distans, Wahl.—83 (?), 85, 86, 87 (?).
Festuca procumbens, Kunth.—81 (?), 83 (?), 85 (?), 86 †.

Festuca rigida, Kunth.—82, 83, 85, 87.
—— rottbœllioides, Kunth.—83 (?), 85, 86.
—— Myuros, L.—Probably †, 81, 85.
—— sciuroides, Roth.—*Not from 79, 82, 84.*
—— ovina, L.—In all.
—— rubra, L., agg.—*Not from 80.* *Var.* arenaria, Osbeck, 81, 83 (?), 85.
—— sylvatica, Vill.—83, 85 (?), 86, 87.
—— elatior, L.—*Not from 80.* *Var.* pratensis, Huds., *not from 78, 84.*
—— arundinacea, Schreb.—78, 83, 84, 85, 86. These records should be revised.
Bromus giganteus, L.—*Not from 78.*
—— ramosus, Huds.—*Not from 78.*
—— erectus, Huds.—82 (S.), 83, 85. A doubtful native.
—— madritensis, L.—Casual, 83, 85.
—— secalinus, L.—83, 84 (S.), 85 (?), 86, 87 (S.). A doubtful native. *Var.* velutinus, Schrad., 83 (?).
—— racemosus, L.—78, 81, 83 (S.), 87.
—— commutatus, Schrad.—*Not from 80, 81, 84.*
—— arvensis, L.—†, 85, 86 (S.).

The species in the section Serrafalcus of the genus Bromus require revision in Forth and Tweed.

Brachypodium gracile, Beauv.—In all.
—— pinnatum, Beauv.—83 (?).
Lolium perenne, L.—In all. *Var.* aristatum, Schum., casual 83. *Var.* italicum, Braun., †, 82, 83, 84, 85, 87.
—— temulentum, L.—†, 82, 87.
Agropyron caninum, Beauv.—*Not from 82, 84.*
—— repens, Beauv.—In all. *Var.* barbatum, Duval-Jouve, recorded from 78, 86, doubtless occurs widely.
—— pungens, R. and S., *var.* littorale, Reichb.—83, 85.
—— acutum, R. and S.—83, 85.
—— junceum, Beauv.—83, 85, 87. The species of Agropyron should be studied.
Lepturus filiformis, Trin.—82, 83 (?), 84, 85 † (?).
Hordeum secalinum, Schreb.—81, 83, 85, 87. Probably not native.
—— murinum, L.—80, 81, 82, 83, 84, 85, 86.
—— marinum, Huds.—84 (S.), 85 (?), 87. Is this native?
Elymus arenarius, L.—82, 85.

## GYMNOSPERMS.

Juniperus communis, L.—*Not from 78* (?) (Pentland Hills), *84, 85* (?).
—— nana, Willd.—87.
Taxus baccata, L.—*Not from 79, 80, 82, 84.* Probably † in most counties.
Pinus sylvestris, L.—In all counties, but usually †.

A number of other conifers are frequent in plantations and shrubberies.

## VASCULAR CRYPTOGAMS.

Hymenophyllum tunbridgense, Sm.—78, 86.
—— unilaterale, Bory.—85, 86, 87.
Cryptogramme crispa, R. Br.—*Not from 82, 83* (?), *84.*
Asplenium Adiantum-nigrum, L.—*Not from 78.*
—— marinum, L.—81, 83, 85.
—— viride, Huds.—83, 84 (?), 85, 86, 87.

Asplenium Trichomanes, L.—In all.
—— Ruta-muraria, L.—In all.
—— germanicum, Weiss.—80, 83 (?), 85.
—— septentrionale. Hull.—80, 83.
Athyrium Filix-fœmina, Roth.—In all, but varieties not distinguished.
—— alpestre, Milde.—86, 87.
Ceterach officinarum, Willd.—81 † (?).
Scolopendrium vulgare, Symons.—*Not from 78, 84.*
Woodsia hyperborea, R. Br.—87.
Cystopteris fragilis, Bernh.—*Not from 78.* *Var.* dentata, Hook., 84, 86.
—— montana, Bernh.—86.
Polystichum Lonchitis, Roth.—86, 87.
—— lobatum, Presl.—*Not from 84.* *Var.* aculeatum, Syme.—81, 83, 85, 86.
—— angulare, Presl.—80, 81, 83 (?), 85.
Lastræa Thelypteris, Presl.—85 (?).
—— Oreopteris, Presl.—*Not from 82, 84.*
—— Filix-mas, Presl.—In all. *Var.* affinis, Bab., 81, 85. *Var.* paleacea, Moore, 85, 86, 87.
—— cristata, Presl.—84, in error.
—— spinulosa, Presl.—88, 83, 85, 86, 87.
—— dilatata, Presl.—In all. *Var.* alpina, Moore, 86.
—— æmula, Brackenb.—80 (?), 81 (?).
Polypodium vulgare, L.—In all. *Var.* serratum, Willd., 86.
Phegopteris Dryopteris, Fée.—*Not from 82.*
—— polypodioides, Fée.—*Not from 78, 82.*
Osmunda regalis, L.—*Not from 78, 79, 80, 83, 85* (?).
Ophioglossum vulgatum, L.—*Not from 78.*
Botrychium Lunaria, Sw.—*Not from 78.*
Equisetum maximum, Lam.—81, 83, 85.
—— arvense, L.—In all.
—— pratense, Ehrh.—83, 84, 85, 86, 87.
—— sylvaticum, L.—In all.
—— limosum, Sm.—In all.
—— hyemale, L.—81, 83, 85 (?), 87.
—— variegatum, Schleich.—82, 85, 86 (S.)
Lycopodium Selago, L.—*Not from 78, 84, 85.*
—— inundatum, L.—85, 87.
—— clavatum, L.—*Not from 82, 84.*
—— alpinum, L.—*Not from 82, 84, 85.*
Selaginella selaginoides, Gray.—*Not from 78, 84.*
Isoetes lacustris, L.—85, 86, 87.
—— echinospora, Dur.—87.
Pilularia globulifera, L.—83, 84, 85, 87.

## CHARACEÆ.

Chara fragilis, Desv.—*Not from 78, 81, 84.* *Var.* barbata, Gant., 79, 81, 86. *Var.* capillacea, Coss. and G., 86. *Var.* Hedwigii, Kuetz., 80. *Var.* delicatula, Braun. 80, 81, 86, 87.
—— aspera, Willd.—79, 85, 87. *Var.* subinermis, Kuetz., 85.
—— polyacantha, Braun.—79, 80, 85.
—— contraria, Kuetz.—82, 85. *Var.* hispidula, Braun, 85.
—— hispida, L.—81, 82 (?), 85 (?). *Var.* rudis, Braun, 80, 82.
—— vulgaris, L.—*Not from 78, 81, 84.*
Nitella translucens, Ag.—83 (?), 85 (?), 86, 87.
—— flexilis, Ag.—86, 87.
—— opaca, A.—*Not from 84.*

## *Carex divisa*, Hudson, as a Scottish Plant.

By Alex. Somerville, B.Sc., F.L.S.

(Read 12th March 1903.)

It may, I believe, be said with truth that few genera of British plants have more felt the inroads of drainage and agriculture than the genus *Carex*—our Sedges—represented in these Islands by some seventy species. Being in the main paludal, that is marsh-loving, plants, the conversion during the past century of tracts of country from undrained areas into ploughed land capable of yielding cereals and root-crops, has limited not a little those areas where the lower-ground *Carices* at least are to be met with, so that the stations for these are now, in many cases, widely dissevered and isolated.

What I have stated has led me to bring before the Society a Sedge to which considerable interest attaches, a species which, though it occurs in various counties in England, in three in Wales, and in Wexford and Dublin in Ireland, has been reliably recorded from but one county only in Scotland—Forfarshire,—where, curiously, it had until lately continued practically *perdu* for no less than eighty-eight years!

The species I refer to is *Carex divisa*, first described by Hudson, a Fellow of the Royal Society of London, in the first edition of his "Flora Anglica," published in London in 1762, that is a hundred and forty years ago. This Sedge was, in the summer of 1901, re-found near Montrose in Forfarshire by a Mr. James Menzies, as mentioned in the "Annals of Scottish Natural History" for that year, at page 230.

In regard to the floral structure of the species it may be said here that the inflorescence consists of a few short spikelets, all similar, and crowded into a somewhat ovate head, each spikelet having several staminate, *i.e.* male, flowers at its top, those below being pistillate. The stems of the plant are erect and very slender, and rise to a height of a foot or more; the leaves too are long and very narrow.

With marshes near the sea as its habitat, *C. divisa* is, in the British Isles, a local plant. In England, for example, we find it occurring sparingly from Cornwall along the south coast, and up the eastern coast as far as to south-east Yorkshire, in which district there is perhaps more of it than anywhere else, for Robinson, in the "Flora of the East Riding," recently issued, says that though not of common occurrence, it is plentiful, where found, at stations near Hull.

Our object here is to refer to what we now know of this Sedge as a Scottish plant. Eighty-two years ago, Sir William Hooker, in his "Flora Scotica," published in 1821, stated, on the testimony of George Don—whose accuracy at that time had not been impugned—that *C. divisa* occurred in a "Marsh near Montrose, and sea-coast of Angus-shire, chiefly in marshy places." Hooker probably obtained his information from an elaborate paper by Don himself, entitled, "Account of the Native Plants in the County of Forfar," which was contributed in 1813 to Headrick's "General View of the Agriculture of the County of Angus or Forfarshire." In this account, on page 31, where allusion is made to the plant under our notice, there occurs the following sentence:—"By the roadside, in coming from the North Water Bridge, he (*i.e.* the botanist) will find the *C. divisa*, one of the rarest *Carices*."

As Hewett Cottrell Watson asks in the "Cybele Britannica" in 1852, was it not strange that neither Mr. Gardiner, whose admirable "Flora of Forfarshire" appeared in 1848, nor any other botanist up to that time, would seem to have verified or confirmed any one station for the plant in Forfarshire? But what shall we say to the fact that until 1901, and completing an interval of eighty-eight years, no botanist had been able, of his own knowledge, to declare *C. divisa* to be a Forfarshire plant, but instead had to fall back on the statement made by Don.

It is indeed satisfactory that Don's doubted information of such old date should, in our day, be proved to be correct. In August of 1901, Mr. James Menzies, a member of the Perthshire Society of Natural Science, brought from a marsh near Montrose some specimens of a *Carex* new to

himself, and submitted them to Mr. William Barclay, Perth, the well-known authority on our wild roses. He, in turn, forwarded them to Mr. Arthur Bennett, F.L.S., our Associate, who replied: "I can make nothing else of the specimens than *C. divisa* of Hudson, a very interesting re-find after many years have passed"; and, he added, "The specimens have evidently been arrested in growth, probably from drought, and are small and not well developed, but they are *C. divisa*, Hudson."

By the meeting by Mr. Menzies with this Sedge in Forfarshire, not only is Don's doubted record of it from that county confirmed, but the plant is with confidence restored to the flora of Scotland.

In the "Phytologist" for 1842, at page 405, there appears a communication from the late Thomas Edmonston, of Shetland, a Professor of Botany for a short time in Glasgow, who, as is known, had a remarkable but brief career. In this communication, Edmonston gives a list of additions made by himself to the known flora of ten miles round Edinburgh, in which list curiously there appears the following item:—"*Carex divisa.* Pentland hills, scarce." Professor Trail, however, in his "Topographical Botany of Scotland," treats this record as unreliable, and as an error, as the occurrence of *C. divisa* in the Pentlands has never been confirmed.

I am indebted for much of the information in this paper to the short article referred to, contributed by Mr. Barclay to the "Annals of Scottish Natural History" in 1901, in which he embodied valuable notes sent to him by Mr. Bennett regarding Don's connection with the Sedge in the county of Forfar, with the plants of which district Don was, as we know, so intimately acquainted.

[At the reading of this paper there was exhibited a dried specimen of *C. divisa*, Hudson, from Forfarshire, and, for comparison, specimens from Suffolk (collected by Mr. E. S. Salmon, F.L.S.), and from Co. Wexford (collected by Miss L. S. Glascott, and confirmed by Mr. Arthur Bennett, F.L.S.)].

## ON THE GENUS POLYSTICHUM, ROTH (ASPIDIUM, SWARTZ, IN PART), WITH SPECIAL REFERENCE TO P. ANGULARE, PRESL., AND TO ITS DISTRIBUTION IN SCOTLAND. By ALEX. SOMERVILLE, B.Sc., F.L.S.

(Read 11th June 1903.)

It is well to be reminded occasionally that our British Ferns, including the Adder's-tongue and Moonwort, number no more than forty-seven species, grouped into twenty genera.

Ferns are the most highly organised of cryptogamic plants, and, by their elegance and grace, never fail to command our admiration, whether we look at the humble moss-like *Hymenophyllum* or at the arborescent tree-fern of Australasia, the Himalayas, and elsewhere.

Though ferns are widely separated from flowering-plants in the important respect that they do not develop nor are reproduced by seeds, but, instead, by microscopic spores filled with structureless protoplasm, they, on the other hand, do claim kinship with phanerogams in possessing an internal vascular structure of stem, of remarkable toughness, which has, doubtless, much to do with the elegance of their outward form.

Fern foliage is strikingly varied, as may be gathered from a survey of our British species. This circumstance helps not a little in classifying the various species. It is not by the foliage, however, so much as by the varied conditions and arrangement found in the fructification, that ferns are grouped. Accordingly it is on inconspicuous points that fern classification is mainly based, points which are often more readily seen before the plant reaches maturity, than when it is in the mature state. The points of distinction require painstaking examination, and the consequence is that the superficial student contents himself with looking to external form, and there being, as it were, two strings to the bow he has to use in determining his plant, he, exercising his choice, selects the easier, and succeeds fairly well.

I have not the intention of entering here on a detailed description of fern fructification and early development; of the *prothallus* and the alternation of generations, on which so much has been written and might here be said, but, as it is the case that no fewer than forty of our forty-seven native species fall naturally into one tribe, the *Polypodieæ* (the remaining seven being peculiar, and grouped in three small tribes), a few remarks regarding the fructification of the *Polypodieæ* may be appropriate.

Fern spores, as said, are microscopic and beyond the unassisted eye to see. In the aggregate they form the fern-dust of imaginative writers. They are not naked and exposed to the atmosphere, but are contained in minute, long-stalked capsules (capable, as is mentioned by Mr. G. F. Scott Elliot, F.L.S., in his recent book, "Nature Studies," of holding sixty-four spores), and known each as a *sporangium*, which bursts when ripe by the rupture of the *annulus* surrounding it, so shedding the spores. These *sporangia*, or spore-cases, are developed on the under surface of the fern frond, and they form, grouped together, the circular patches known each as a *sorus*, which are so well seen in the common Polypody. These *sori*, except in two small genera, *Polypodium* and *Gymnogramme*, are protected, being sheltered by an umbrella-like covering, known as the *indusium*, which is either circular and button-like, or kidney-shaped, or continuous with the reflexed margin of the frond itself.

In the genus *Polystichum*, our shield-ferns now under notice, the *indusium* which covers the *sporangium*-cluster is orbicular, *i.e.* circular, and it is also peltate, *i.e.* target-shaped or shield-like, in being attached by the centre of its under surface to the surface of the fern itself by a stalk. This shield-shaped *indusium* is the cause of the plants being called shield-ferns.

Of the genus *Polystichum* there may be said to be three British species, viz. *Lonchitis*, *aculeatum*, and *angulare*. We are at present showing the last-named, *angulare*, because of the fact that it is a plant of apparently increasing rarity, "whether," as Mr. Arnold Lees remarks, from being "a running-out species, or one that has decreased from

eradication, it is difficult to decide." Many good Scottish botanists have never seen *P. angulare* growing. I show specimens gathered forty years ago by Mr. P. Neill Fraser of this Society, on Great Cumbrae Island, where I fear it is now quite extinct, and also from Loch Ranza, Arran, in which island I am doubtful if it is now to be found. I also show specimens obtained many years ago at Inverkip, Renfrewshire, where, and along the coast to Skelmorlie, it used to be plentiful. Dr. Thomas Scott, F.L.S., records it from above Greenock, and Mr. D. A. Boyd, from Portincross, Ayrshire; and Mr. John Smith, Kilwinning, also is acquainted with three spots in Ayrshire where it occurs. I show a specimen obtained by myself last year in the extreme south of Ayrshire.

Perhaps the most interesting of the sheets shown is that of specimens gathered by me in the woods at Skipness, in the Kintyre peninsula, in 1899. This record of the plant, with the exception of one from Lochgilphead, noticed in Moore's "Nature-Printed Ferns," published forty-four years ago, and of which there seems to have been no subsequent confirmation, is, according to Professor Trail, the only record from Argyllshire, or from any part of the west of Scotland north of Arran. Mr. Charles T. Druery, F.L.S., President of the Pteridological Society, who has seen my Skipness specimens, says, as his label attached shows: "This is *P. angulare*, beyond a doubt, despite the locality."

The only other counties in Scotland from which *P. angulare* seems to be definitely recorded, and which, with one exception (viz. the first), are given in Professor Trail's "Topographical Botany of Scotland," are Kirkcudbright, in the parish of Kells; Wigtown,—these both as recorded by our Associate Member, Mr. James M'Andrew; Roxburgh; and Berwick, at Pease Dean, where Rev. Dr. Paul states it to be abundant; and there is also an old doubted record from Midlothian.

In Ireland, which seems to have a congenial soil and atmosphere for the growth of the plant, we find it occurring, according to Prægers "Irish Topographical Botany," in every county, and in England it is also widely distributed, being recorded from Cornwall and Northumberland, and from many intervening counties.

In concluding, I should like to refer briefly to the points which distinguish from one another the three British species of shield-ferns, viz. *P. Lonchitis*, *P. aculeatum*, and *P. angulare.*

It will no doubt surprise some that we do not here include *lobatum*, especially as it is a name used both in an aggregate and in a segregate sense in the "London Catalogue of British Plants." Opposite views are held as to whether we have two distinct plants in *lobatum* and *aculeatum*. The balance of opinion seems to be with those who consider that we have but one, viz. *aculeatum*, and that what has been known as *lobatum* is but an early or immature state of the former, with the fronds more lanceolate and rigid, and with pinnules confluent and decurrent, or that at best it is but a variety of *aculeatum*. Newman, in his "History of British Ferns," Ed. 3, p. 112, published in 1854, gives it as his opinion—(1) That the dividing of the bipinnate aculeate ferns into three species—*lobatum*, *aculeatum*, and *angulare*—probably originated in an error of nomenclature, due to the various independent namings of Linnæus, Hudson, Küntze, Willdenow, and Sir J. E. Smith; (2) that the three names, *lobatum*, *aculeatum*, and *angulare*, were not intended to represent three objects; and (3) that there was a disposition to reunite them as one species. Thomas Moore, in referring to this in his "Nature-printed British Ferns," published in 1859, says: "It is doubtful if Linnæus knew anything of *angulare*, though there is hardly any room to doubt that he included the other two under *aculeatum*." This, Moore says, is the view which he himself and Newman had both adopted.

One or two more recent opinions on this matter may also be mentioned. 1. We find Mr. F. Arnold Lees, perhaps the best botanist in the north of England, remarking as follows in his "Flora of West Yorkshire," published in 1888:—"The form *lobatum* of Smith is frequent wherever the type occurs, but is not a true variety." 2. Mr. Charles T. Druery, to whom I have submitted a considerable series of what might be supposed to include examples of both *lobatum* and *aculeatum*, replied: "I do not consider there is any real distinction between

so-called *lobatum-genuinum* and *aculeatum*." 3. Mr. Wm. Stewart, Glasgow, has no belief in *lobatum* as a sub-species, and considers it only a form of *aculeatum*. 4. Mr. Robert Kidston, F.R.S., who informs me that "a specimen of *lobatum*, under cultivation, eventually assumed the typical form of *aculeatum*, though the change in assuming the typical form of *aculeatum* took some years to accomplish." From all this it would seem that *lobatum* is but an early state of *aculeatum*.

Of the three acknowledged British species, then, of *Polystichum*, we take first *P. Lonchitis*, looked on as the type of the genus, and occurring in all four divisions of the Kingdom. It is a mountain rock-plant,—rather almost an arctic species, for it is found in the high latitudes of Europe, Asia, and America, and also in the Himalayas. It ranges on the Breadalbanes up to 3400 feet, and is found most frequently nestling below large boulders. It is the most hardy British fern, and an evergreen. Its main characteristic is that its numerous and sometimes overlapping *pinnæ* are not divided into pinnules. In its mature state, this, which we know as the Holly Shield-fern, is not confoundable with either of the other two.

Regarding *P. aculeatum* and *P. angulare*, though these, when normally grown, are sufficiently distinct from one another, they are occasionally somewhat closely alike, and liable to confuse even the experienced eye. Various points of distinction may be touched off as follows, viz.:—

1. *aculeatum* is more glossy in appearance, and more rigid in texture;
   *angulare* is more lax and drooping, and the teeth of the leaves being long-awned, the whole plant is softer in appearance and to the touch.
2. *aculeatum* has its pinnules wedge-shaped, *i.e.* shaped like an acute angle at their base or point of attachment, and they are almost sessile, *i.e.* they can hardly be described as stalked;
   in *angulare*, on the other hand, the base of the pinnules is in the form almost of a right angle, and the pinnules are distinctly stalked, so distinctly, Dr. Thomas Scott remarks, that when

the frond is held to the light there is seen a clear line along each side of the axis of the *pinna*, between it and the pinnules, a line quite absent in the case of *aculeatum*. Further, with regard to the pinnules of *angulare*, it is also pointed out by Dr. Scott that they possess a characteristic rounded lobe at the lower outer extremity of the triangle, a lobe absent in *aculeatum*.

3. In *aculeatum* the *pinnæ* of the lower part of the *rachis* gradually diminish in size downwards till near its lower end;
   in *angulare* the *pinnæ* stop abruptly, and somewhat higher up the *stipes*, or part of the stem below the *pinnæ*.
4. In both species, while the *stipes* is clothed with membranous, chaffy, reddish-coloured *ramenta* or scales, these scales, in the case of *angulare*, are larger, shaggier, and more copious than in *aculeatum*.

I have to apologise, not only for the length of this "Note," but also for the fact that so much that is stated in it is common knowledge, still I hope it may afford interest to some, and that it may also stimulate a desire to study those nature-forms to which we have been referring.

## Report of the 1902 Excursion of the Scottish Alpine Club. By Alexander Cowan, Esq.

(Read 8th January 1903.)

The members of the Scottish Alpine Botanical Club met at the Caledonian Station, Edinburgh, on Monday, the 28th July 1902, and travelled to Tyndrum, where it had been arranged to hold the Annual Meeting, and where comfortable quarters were found in the Royal Hotel. On the following day, Tuesday, the 29th July, the members present, viz.:—Mr. Boyd, President; Dr. Paul, Vice-President; Dr. Craig, Dr. Church, Mr. Potts, Mr. Crawford, together with the writer, who was present as a visitor

on the invitation of the President, drove down the valley to the foot of Ben Laoigh, whose summit, owing to the unfavourable weather, was clothed in mist. The members spent the greater part of the day examining the rocks on the north side of the mountain. All the well-known plants were found. It is therefore considered unnecessary to give a list. The members returned in the afternoon by the same route, with the exception of two of the party who walked round the mountain in order to explore the Corrie, where the Parsley Fern, *Allosorus crispus*, was found in large quantity and in great luxuriance. Only one member of the party climbed to the summit, and he had a most unpleasant and uncanny experience in the thick wetting mist, no view, of course, being possible.

The Annual Business Meeting of the Club was held in the evening.

The second day, Wednesday, the 30th, was spent at Loch-na-bee, where plants of the supposed *Scirpus fluitans* were obtained. Two of the party afterwards explored the hill at the south side of the loch, but found nothing new except a species of *Salix*, with which they are unacquainted, and which has yet to be named.

On the third day, Thursday, the 31st, the members went by train and steamer to Port Sonachan on Loch Awe, where two nice varieties of the Lady Fern were found by Mr. Boyd, plants of which were secured.

The weather, which on the first day was damp and unpleasant, was on the whole fair; but the meeting, as far as regards the plants of any interest found, was a disappointing and unsuccessful one. The *Cystopteris montana*, it is gratifying to add, was seen in such quantity that it is not likely soon to become extinct. *Kobresia caricina* was found in considerable quantity also, but probably owing to the cold season was not over four inches high, and *Azalea procumbens* was seen in large quantity.

The attendance of members, which was not large to begin with, was still further reduced before the end of the meeting, owing to some of those present having to leave to keep other appointments elsewhere. The meeting broke up on Friday, 1st August.

## NOTES ON A CENSUS OF THE FLORA OF THE AUSTRALIAN ALPS.

By JAMES STIRLING, A.I.C.E.; Gov. Geolst. of Victoria; Cor. Mem. Linn. Soc. N.S.W.

(Read 12th February 1903.)

In preparing a census of the Flora of the Australian Alps, the author has in view an inquiry into the origin and distribution of the mixed types of plants now flourishing on the higher altitudes over South-East Australia, and its relation to the Tertiary Floras of South-East Australia.

The present census is a preliminary contribution towards that object, and as an aid to correlation with other Alpine Floras.

During the years 1875 to 1888 he collected 1019 species of plants in the valleys, ridges, peaks, and tablelands of the region, at elevations between 2000 and 7000 ft., most of which were named by the late Baron Ferdinand von Mueller, Government Botanist.[1] The area over which the plants were collected stretches from the heads of the Yarra River in Victoria, in a north-east direction along the main watershed line dividing the streams flowing north into the Murray River from those flowing south and south-east, to the Gippsland Lakes and the Southern Ocean; and in the lateral watershed lines and tablelands to the region around Mount Kosciusko in New South Wales; and covers an area of about 15,000 square miles.

The general study of the Flora shows[2] that here, as elsewhere, climatic conditions have exerted a dominating influence in the evolution of varietal forms. This is particularly noticeable in the Myrtaceæ, especially in the genus *Eucalyptus*. It has been pointed out that—

"The existence of small colonies of mountain species in the lowlands, as, for instance, *E. pauciflora* and *E.*

[1] "Phanerogamice of Mitta Mitta Source Basin." Trans. Roy. Soc. Vict., Part I., 1882; Part II., 1884.

[2] "Physiography of Australian Alps." Trans. Aust. Assoc. for Advancement of Science, Sydney Meeting.

*viminalis* (*b*), points to survivals from a time when the climate was much colder than it is now. The oscillations of level which have affected the coast-line of the southern half of this continent may be well studied in Gippsland. These must certainly have produced variations of climate extending back beyond the Cainozoic period.

"The Gippsland Alps have not been submerged beyond a contour line of some 800 to 1000 ft. above sea-level, not only during that period of time, but that land surface must have been continuous backwards to the time when the Mesozoic coal measures of Gippsland were formed.

"The lauraceous and other plants which have been found in the Miocene[1] drifts of Gippsland indicate, as does also the fauna of the marine limestones of that district, a warmer climate than of the present day.

"Lake Karng at Mount Wellington, if a moraine lake, points, on the other hand, to an Alpine climate, descending to within at least 3000 ft. of the sea-level. Such changes of climate have evidently been attended by a corresponding change in the Tertiary Flora, in which that element, which is now characteristic of Australia, has gradually predominated. Such changes of climate may also account in part for the great number of recorded types of Eucalypts and their varieties, and of which no less than 35 occur in Gippsland.

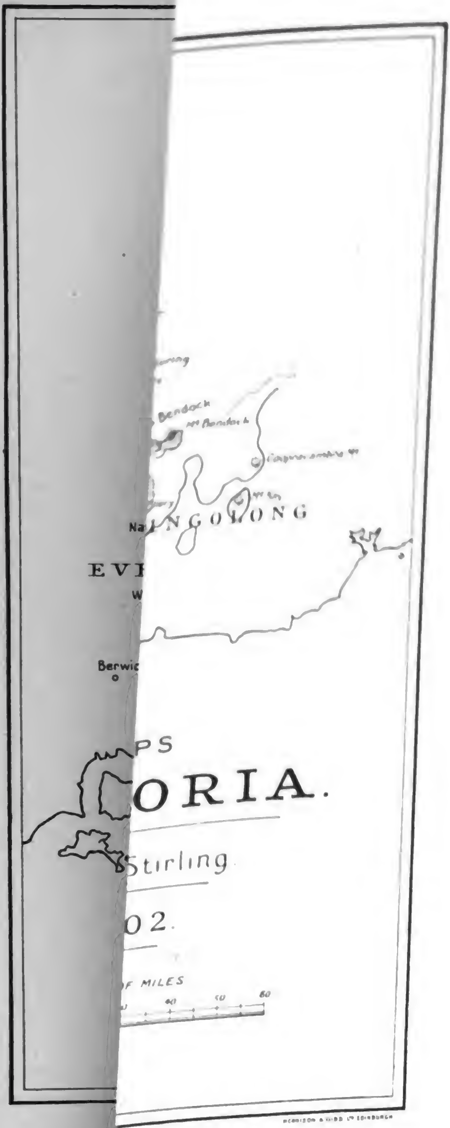
"Geological formation, as producing variation of soil, has no doubt influenced the present distribution of the Eucalypts, but its effect cannot be made out so clearly as those produced by climate; but the broad features can be readily seen by anyone travelling through Gippsland."[2]

## PHYSICAL FEATURES OF THE MAIN WATERSHED LINE OR DIVIDING RANGE.

The physical features of the main watershed line present a diversity of contour: long sinuous ridges rising into flat-topped mountains, as Mount Howitt; to coned

[1] Now classed as Eocene.

[2] "The Eucalypts of Gippsland." A. W. Howill, S.S.C. Trans. Roy. Soc. Vict.


Bendoch
ORIA.
Stirling
MILES
40
50
60

peaks, The Twins, 6000 ft.; to dome-shaped heights, as Mount Hotham, 6100' ft; broadening out into flat expanses of tableland at lower levels, as Baw Baw Plains, 5300 ft.; descending into low gaps or saddles, as Tongio Gap, near Omso, 3000 ft.—thus affording an easier access from the northern basin to the seaboard; and again rising into rugged and escarped mountains, as Mounts Tambo, 4700 ft., and Cobberas, 6025 ft.; or into aguille-shaped peaks, as Mount Pilot; or the still loftier irregular contours of the snow-clad mountain plateaux surrounding Mount Kosciusko, 7250 ft. above sea-level.

Lofty tablelands occur on the lateral watershed lines; those north of the main watershed line in Victoria comprise the Bogong High Plains, 6000 ft., and the Omeo Plains, 3000 ft. This depressed tableland, which covers an area of 24 square miles, has a small lake in its centre, 3½ miles long by 1½ wide, which is fed by rains and storm-waters from the surrounding hills. It has no visible outlet, the character of the surrounding country consisting of open treeless plains, merging by gentle slopes into the encircling timbered ranges. Those south of it comprise the Snowy Plains, about 5000 ft.; Dargo High Plains, 5000; and the Nuninyong and Gelantipy tablelands, each over 3000 ft. above sea-level.

In close proximity to one of these plateaux (Bogong High Plains), on a lateral watershed line, the highest peaks in Victoria are situated, notably, Mount Bogong, 6508 ft. at its northern extremity; Mount Cope, 6015 ft. at its eastern rim; and Mount Feathertop, 6303 ft. at the south-west margin.

The physical features and climatic conditions of all the higher plateaux are distinctly Alpine. Flat expanses of moorland, and undulating rises, covered with alpine flowers and snowgrasses, mosses, and lichens, at the sources of springs; and groups of gnarled and stunted gum scrub (eucalyptus) on the lower lying shelves. Although the surface is rocky in parts, the soil of most of the tablelands, except that of the Mount Kosciusko plateau, is rich volcanic, and is highly productive. During midsummer, about the beginning of February, these highlands are covered with a most luxuriant verdure, the richness and

softness of which is hardly conceivable by those who have not seen similar localities. The bright emerald tinted carpeting of snowgrasses, the variegated colours of numerous herbaceous plants, and dwarfed but diffuse shrubs, with crystal streams (small source runnels) traversing the area, make a most striking contrast to the brown and parched appearance of the lower lands and valleys, literally languishing in excessive dryness at this season of the year. The grandeur and sublimity of the surrounding scenery, seas of mountains rising wave-like on every side, presenting almost infinite shades of blue and purple colouring, the extreme rarity of the air and other conditions which lend an additional charm to the landscape, leave an impression on the mind of the beholder not easily effaced. Although these highlands form excellent summer pasturages, upon which stock fatten rapidly—so rich and nutritive is the herbage,—yet, owing to the severe frosts, snow, and sudden climatic changes, they are for many months of the year perfectly inhospitable. Snow frequently falls to a depth of twelve feet in these regions, and, where at all shaded from the sun's direct rays, remains throughout the entire summer, forming young glaciers, which, however, never mature, owing to the variation in summer temperature, to which even these regions are subject.

Some of the evidences of this ancient highland are found in the localities now occupied by coatings of basalt overlying widespread river gravels and clay stones (which contain the remains of Eocene flora) resting on silurian or metamorphic rocks. Some of the present rivers, such as the Mitchell, Dargo, and Mitta Mitta, have eroded their courses along the margin of these lava flows to a depth of 4000 feet, leaving the height of the underlying Eocene strata and the depth of the basaltic coating plainly discernible.

The present elevated plateaux, as might be expected, form the gathering grounds of most of the principal streams, traversing deep valleys with extremely picturesque contours, such as the Snowy River, Mitchell, and Latrobe, flowing south into the Southern Ocean and the Gippsland Lakes; and the Murray, Mitta Mitta, Ovens, King, and Goulburn Rivers flowing north and north-west.

The main watershed line is not an original axis of elevation, but on the contrary has assumed its present position by a long continuous process of denudation and erosion from a once extensive highland existing during later Eocene, or early Miocene times. High ridges of Silurian slates, in which auriferous quartz veins occur, as Mount Feathertop, 6300 ft. above sea-level, and bold rounded mountains of granite or granitiform gneiss, and metamorphic rocks, as Mounts Buffalo, 6000 ft., and Bogong, 6508 ft., stand out on the lateral watershed lines. Some of the peaks on the main watershed line, such as the Cobberas Mountain, 6075 ft., are the cores and surrounding consolidated ash-beds, etc., of old palæozoic volcanoes of Lower Devonian age. While on the flanks of the Main Divide, isolated and now elevated remnants of the old Middle Devonian seabeds occur as limestone or sandstone beds, at an elevation of from 1000 to 3000 feet, as at Bindi, Buchan, Tabberabbera, etc. Massive conglomerated sandstones, and inter-bedded igneous rocks, forming rugged heights and cliffs of Upper Devonian age, cover a considerable portion of the area, as the bold escarpments of the Moroka Valley at Snowy Bluff, and Mount Tambo, near Omeo Plains.

Magnificent Eucalyptus forests clothe the sub-alpine levels, certain species, as *Eucalyptus sieberiana*, occurring in altitudinal zones, others, as *E. Gunnii*, *E. stellulata*, and *E. pauciflora*, struggle up as stunted gnarled stems to the elevation of 6800 ft. on the northern slopes. At the highest elevations arboraceous vegetation is entirely absent, or represented by low diffuse and gnarled varieties of *E. pauciflora*. Several of the herbaceous plants of the higher altitudes may be cultivated as esculents, and others used medicinally. The edible plants of cold temperate climates could be cultivated successfully in a large extent of this mountainous country.

There is great variation in many composite herbs of the Australian Alps during different seasons, sports being abundant in dry seasons, and the reversion to foliaceous forms very remarkable.

Among medicinal plants flourishing in the sub-alpine areas are *Atherosperma moschatum* (or native sassafras), *Daviesia latifolia* (the native hop), *Comesperma volubile*,

*Drimys aromatica* (native pepper tree), *Aciphylla glacialis* (native parsnip), *Leptomeria aphylla* (native cranberry), *Pimelia axiflora* (native hemp), and many Eucalyptus trees and myrtaceous shrubs yielding valuable oils.

In the eastern region adjacent to the Australian Alps, especially in the watershed of the Snowy River valley, there is a remarkable commingling of types of a tropic facies with others of a distinctively antarctic character The Snowy River finds its source runnels in the Mount Kosciusko plateau, 7000 ft. above sea-level, and the Maneroo tableland at lower altitudes in the southern portion of the state of New South Wales.

In this region may be seen the effects of varying hygrometric and other meteorological conditions in the evolution of varietal forms, such species as *Craspedia Richea*, *Helichrysum rosmarinifolium*, among the Compositæ; *Daviesia latifolia* and several *Acacias* among the Leguminosæ; and in the forms of the arboreous *Drimys aromatica*, and *Panax sambucifolius*; several myrtaceous shrubs; *Styphelia ericoides*, *Gentiana saxosa*, and the ubiquitous *Wahlenbergia gracilis*.

Of the 10,000 species of plants peculiar or indigenous to Australia, not more than one-tenth occur in the Australian Alps at altitudes above 2000 ft., or in the altitudinal zone between 2000 and 7000 ft.

The proportion between the Phanerogams and Cryptogams of the species collected is as follows:—

| | | |
|---|---|---|
| Phanerogams (80 orders) . | 249 genera | 678 species. |
| Cryptogams . . . . | 161 „ | 341 „ |
| | 410 „ | 1019 „ |

There is much work to be done in the latter division before a final comparison can be made.

It will be seen that of the known 182 natural orders of Phanerogamic plants occurring in Australia, nearly one-half occur in the Australian Alps.

The principal orders of plants which contain the greatest number of genera and species are as follows:—

| | | | |
|---|---|---|---|
| Musci | 47 genera | 96 species | 25 species above 5000 ft. |
| Leguminosæ | 22 " | 76 " | 19 " " |
| Compositæ | 25 " | 74 " | 28 " " |
| Filices | 23 " | 50 " | 6 " " |
| Myrtaceæ | 7 " | 42 " | 8 " " |
| Cyperaceæ | 10 " | 36 " | 7 " " |
| Gramineæ | 19 " | 35 " | 22 " " |
| Lichens | 17 " | 35 " | 35 " " |
| Epacrideæ | 6 " | 34 " | 9 " " |
| Proteaceæ | 6 " | 30 " | 7 " " |
| Orchideæ | 9 " | 26 " | 1 " " |
| Rutaceæ | 4 " | 24 " | 11 " " |
| Labiatæ | 8 " | 17 " | 3 " " |
| Liliaceæ | 11 " | 16 " | 1 " " |
| Scrophularineæ | 5 " | 14 " | 7 " " |
| Umbelliferæ | 9 " | 13 " | 6 " " |
| Euphorbiaceæ | 9 " | 12 " | 1 " " |
| Caryophylleæ | 5 " | 12 " | 7 " " |
| Goodeniaceæ | 4 " | 11 " | 1 " " |
| Ranunculaceæ | 3 " | 11 " | 7 " " |

Thus it will be noted that the Lichens, Compositæ, Mosses, Gramineæ, and Leguminosæ are represented by the greatest number of species at the altitudes above 5000 ft.; the Rutaceæ, Epacrideæ, Myrtaceæ, Scrophularineæ, Ranunculaceæ, Caryophylleæ, Proteaceæ, Cyperaceæ, Ferns, and Umbelliferæ coming next in the order given.

The numerical proportion of the species of Phanerogams represented in the Australian Alps as distributed in the different Australian States is as follows:—

| | |
|---|---|
| Victoria | 678 |
| New South Wales | 588 |
| Tasmania | 355 |
| Queensland | 228 |
| W. Australia | 112 |
| S. Australia | 35 |

The greater number in New South Wales is accounted for by the fact that a considerable portion of the Australian Alps, including the highest altitudes above 6500 ft., is in the southern part of that State; although the greatest areal extent of the mountain ranges and lateral tablelands, known as the Australian Alps, or where the maximum number of species occur, is in Victoria.

The strictly endemic species are not less than sixty, and those endemic to South-East Australia and Tasmania amount to about ninety.

On the whole, there is a greater affinity with the Tasmanian Alpine Flora than with that of any other region.

Analysing the orders richest in species in relation to other floras, or comparing the relative magnitudes of the nine largest orders, we get the following:—

| AUSTRALIAN ALPS. | AUSTRALIA. | TASMANIA. | NEW ZEALAND. | WORLD. |
|---|---|---|---|---|
| Leguminosæ | Leguminosæ | Compositæ | Compositæ | Compositæ |
| Compositæ | Myrtaceæ | Orchideæ | Cyperaceæ | Leguminosæ |
| Myrtaceæ | Proteaceæ | Epacrideæ | Gramineæ | Gramineæ |
| Cyperaceæ | Compositæ | Leguminosæ | Scrophularineæ | Orchideæ |
| Gramineæ | Gramineæ | Cyperaceæ | Orchideæ | Rubiaceæ |
| Proteaceæ | Cyperaceæ | Gramineæ | Rubiaceæ | Euphorbiaceæ |
| Orchideæ | Epacrideæ | Myrtaceæ | Epacrideæ | Labiatæ |
| Epacrideæ | Goodeniaceæ | Liliaceæ | Umbelliferæ | Myrtaceæ |
| Rutaceæ | Orchideæ | Proteaceæ | Ranunculaceæ | Cyperaceæ |
| Labiatæ | | | | |
| Liliaceæ | | | | |
| Umbelliferæ | | | | |
| Scrophularineæ | | | | |
| Ranunculaceæ | | | | |
| Euphorbiaceæ | | | | |
| Goodeniaceæ | | | | |
| Caryophylleæ | | | | |
| Pittosporeæ | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Leguminosæ | has most species in | S.E., | next in | S.W. | of Australia, | least in | tropics. |
| Compositæ | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |
| Myrtaceæ | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |
| Cyperaceæ | ,, | S.W. | ,, | S.E. | ,, | ,, | tropics. |
| Gramineæ | ,, | tropics | ,, | S.E. | ,, | ,, | S.W. |
| Proteaceæ | ,, | S.W. | ,, | S.E. | ,, | ,, | tropics. |
| Orchideæ | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |
| Epacrideæ | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |
| Rutaceæ [1] | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |
| Ranunculaceæ | ,, | S.E. | ,, | S.W. | ,, | ,, | tropics. |

[1] Rutaceæ, after Australia, abounds most in India.

In his introductory essay to the "Flora of Tasmania," Sir J. D. Hooker remarks that the chief peculiarities of the Australian flora, as a whole, are, that it contains more genera and species peculiar to its own area, and fewer plants belonging to other parts of the world, than any other country of equal extent; about two-fifths of its genera, and upwards of seven-eighths of its species, are entirely confined to Australia; that many of the plants have a very peculiar habit of physiognomy, giving in some cases a character to the forest scenery, as Eucalypti, Acaciæ, Proteaceæ, Casuarineæ, Coniferæ; are themselves of anomalous or grotesque appearance, as Xanthorrhœa, Casuarina, Banksia, etc.

Many genera and species display singular peculiarities,

as the ovules of Banksia; calyptra of Eucalyptus; stigma of Goodeniaceæ; staminal column of Stylidium; irritable labellum of various Orchideæ; flowers sunk in the wood of some Leptospermeæ; pericarp of Casuarina; receptacle and inner staminodia of Eupomatia; and stomata of Proteaceæ.

Notwithstanding these peculiarities, Hooker considers that it is impossible to regard the Australian vegetation in any other light than as forming a peculiar, but not aberrant or anomalous, botanical province of the existing vegetable kingdom.

The great specific difference between the plants of the south-eastern and south-western parts of Australia is referred to as being greater than that between Australia and the rest of the globe.

It is also pointed out that most of those Australian orders and genera which are found in other countries round Australia have their maximum development, in Australia, at points approximating in geographical position towards those of neighbouring countries.

It is noteworthy that the following orders represented in the Australian Alps abound, after Australia, most in South Africa, or in extra tropical South Africa:—Proteaceæ, Rutaceæ, Restiaceæ, Thymeleæ, Droseraceæ, Polygaleæ, Santalaceæ, Irideæ, Epacrideæ, and Rubiaceæ.

The forecast given by Sir J. D. Hooker that the antecedents of the peculiar Australian flora may have inhabited an area to the west of the Australian continent, analogous with South Africa, and that the bonds of affinity between the Antarctic, Australian, and South African floras indicate them as members of one great vegetation which may have covered as large an area as the European does in the northern hemisphere, is one which, I think, receives ample confirmation by the most recent phytographic research.

It is also noteworthy that a number of plants from the mountains of New Guinea occur in the Australian Alps. There is also a mixture of forms peculiar to the Himalayas; Kurrum Valley, Afghanistan; the mountains of North Borneo; and Morocco (Africa).

The occurrence of New Zealand and Polynesian types of plants in the Australian Alps and Tasmania, along with

distinctively antarctic types is peculiar. It is suggested that the Polynesian features have been derived from some Pacific islands which have since been overrun by an Indian vegetation, and Tasmania peopled by New Zealand and antarctic forms before the Australian vegetation spread over it and replaced them. Such Australian genera as *Eriostemon, Kennedya, Acacia, Leptospermum, Banksia, Didiscus, Coprosma, Leucopogon, Lomatia, Grevillea, Exocarpos, Casuarina, Araucaria, Microtis, Stypandra*, etc., are represented by species in the New Hebrides and New Caledonia.

The following genera and species occurring in the Australian Alps, some of which are European forms, are represented in the floras of the islands south of New Zealand (Fugean and Kerguelen islands):—*Caltha introloba, Drimys aromatica, Cardamine hirsuta, Drosera Arcturi, Stellaria media, Sagina procumbens, Colobanthus subulatus, Geranium dissectum, Pelargoniums, Oxalis magellanica, Geum urbanum, Acæna Sanguisorbæ, Epilobium tetragonum, Myriophyllum elatinoides, Apium australe, Oreomyrrhis andicola, Coprosma hirtella, Erechthites, Stellaria radicans, Gentiana montana, Limosella aquatica, Samolus repens, Plantago Brownii, Chenopodium glaucum, Lomatia ilicifolia, Fagus Gunnii, Astelia, Juncus bufonius, Oreobolus Pumilio, Hierochloe redolens, Trisetum subspicatum*, and *Festuca*.

While the anomalies between the New Zealand and the Australian vegetation are certainly very great, yet there are numerous points of affinity which are all the more remarkable. Among these is the great amount of generic affinity in the three largest orders—Compositæ, Orchideæ, and Gramineæ. Hooker states that of the 240 genera of Australian plants common to New Zealand, 60 are almost exclusively confined to the two areas, while fully one-quarter of the New Zealand species of Phanerogams are natives of Australia, 115 being confined to the two countries, and that 20 of these are alpine plants in both countries. The greatest generic affinity exists among the Cryptogams.

The proportion between the arboreous, semi-arboreous (shrubs), and herbaceous plants, excluding the Gramineæ and Cryptogams, is as follows:—168; 46; 162.

Dividing Range, Head of King River (p. 320).

Mount Feathertop (p. 321).

Exploring Party on Mount Kosciusko plateau (p. 321).

In a Eucalyptus Forest, sub-alpine level (p. 323).

STUNTED GUM SCRUB AT 6800 FEET (p. 323).

*Pomaderris apetala* (p. 363).
GIPPSLAND FOREST SHRUBS.

The several classes of mountains so ably described by Professor Geikie in the "Transactions of the Royal Scottish Geographical Society"[1] are represented in the Australian Alps.

The Cobberas Mountains are examples of the Tectonic class, and Mounts Tabletop, Tambo, etc., of the Relict class.

The order RANUNCULACEÆ is represented by a number of Alpine herbs, among which is the apparently endemic *Caltha introloba*, so closely resembling a New Zealand species. The large white-petalled *R. anemoneus* is a striking floral feature of the Australian alpine areas, along with the yellow-petalled buttercups, *R. Muelleri* and *R. Millani*.

The order DILLENIACEÆ is represented by a single genus *Hibbertia*, with six species ascending to sub-alpine habitats between 3000 and 4000 ft., such as *H. stricta*, *H. serpyllifolia*, *H. linearis*, *H. diffusa*, *H. dentata*, and *H. pedunculata*.

MAGNOLIACEÆ is represented by *Drimys aromatica* (the native pepper tree), at elevations of from 2000 to 4000 ft. This species forms a handsome small tree. At the higher alpine levels between 5000 and 6000 ft. it is dwarfed to a low diffuse and gregarious shrub with thick leaves and bark.

MONIMIEÆ is represented by two beautiful trees at sub-alpine habitats, *Atherospermum moschatum*, the native sassafras of medicinal value for heart affections, and the handsome foliaged *Hedycarya Cunninghami*. Both ascend in humid gullies to 4600 ft. elevation.

LAURACEÆ is only represented by the peculiar climbing plants *Cassytha melantha* and *C. glabella*, which cover shrubs up to elevations of 4000 to 5000 ft.

The European order CRUCIFERÆ is represented by mostly European genera, the ubiquitous *Cardamine hirsuta* now occurring all over the Alps up to 7000 ft., along with

[1] Scottish Geographical Magazine, 1901, September, vol. xvii.

*Erysimum capsellinum* up to 6500 ft., *C. dictyosperma* at 5000 ft., and an Arabis, *A. glabra*, at 4800 ft.

VIOLACEÆ.—There are several genera at the higher levels. *Viola caleyana* ascends to 6500 ft., *V. betonicifolia* and the procumbent *V. hederacea* ascend to 5000 ft., *Hybanthus filiformis* to 4000 ft., and the ever fragrant *Humenanthera Banksii*, which forms a small tree at the lower levels up to 3000 ft., and a spinous shrub, var. *angustifolia* at the higher altitudes up to 6000 ft.

None of the genera of the order PITTOSPOREÆ are represented above 4600 ft. *Pittosporum bicolor*, which forms a small robust tree at the lower levels of 2000 ft., is reduced to a small shrub at the sub-alpine levels of 4000 ft. Similarly *Bursaria spinosa*, which at the lower sub-alpine limestones of Bindi is a profusely flowering and fragrant small tree, is dwarfed to a spinous divaricate shrub at 4000 ft.

*Billardiera longiflora* and *B. scandens* ascend to 4000 ft.

DROSERACEÆ. — Two species of the genus *Drosera* are common. One, a distinctly alpine form, *D. Arcturi*, flourishes in damp flats near melting snow at 6000 to 7000 ft.; the other, *D. auriculata*, ascends in sub-alpine habitats to 4000 ft. Both species are insectivorous.

HYPERICINEÆ. — *Hypericum japonicum*, in the form of a var. *gramineum*, ascends to 5000 ft. levels.

POLYGALEÆ.—One genus, *Comesperma*, is represented by species at the higher levels, *C. ericinum* up to 6000 ft., and *C. retusum* to 4000 ft. Another interesting species, *C. volubile*, only reaches the lower sub-alpine habitats at 3000 ft. The root of this species is of medicinal value, having an agreeable sarsaparilla flavour.

RUTACEÆ.[1]—Among Rutaceous plants none are more generally distributed than the Native Fuchsia, *Correa lawrenciana*, especially on the sub alpine littoral slopes, where it is frequently gregarious.

[1] *Vide* "Notes on the Rutaceæ of the Australian Alps." By J. Stirling. Trans. Linnæan Society, New South Wales.

The arboreous *Zieria Smithii*, var. *macrophylla*, ascends in sub-alpine habitats to 4800 ft. Among *Boronias*, *B. algida*, *B. pilosa*, and *B. polygalifolia* are common all over the highest altitudes between 4000 and 6500 ft.

The genus *Eriostemon* contains a number of hardy species, apparently endemic to our Australian highlands, including the sparsely distributed *C. ozothamnoides*, a robust shrub on rocky situations. *E. phylicifolius* is common between 4000 and 6000 ft., together with *E. trymalioides*; *E. alpinus* and *E. ovatifolius* grow luxuriantly on the high mountain tops, between 4500 and 7000 ft.; also *E. correifolius*. All the other species ascend to 4000 ft.

LINEÆ. — The ubiquitous *Linum marginale*, or native flax, is robust at 5000 ft.; it is thicker stemmed and larger leaved, with deeper blue flowers, at the higher levels.

GERANIACEÆ.—*Geranium sessiliflorum* ascends to 5000 ft., along with *Pelargonium australe*, and the endemic *Oxalis*, *O. magellanica*. The ubiquitous *O. corniculata* also ascends to 5000 ft.

MALVACEÆ. — Only one species, *Plagianthus pulchellus*, ascends to sub-alpine areas of 3000 ft.

STERCULIACEÆ. — Two genera are represented at sub-alpine habitats, *Commersonia dasyphylla* up to 4500 ft., and *Lasiopetalum dasyphyllum* up to 4000 ft.

TILIACEÆ. — Only one species, *Elæocarpus holopetalus*, ascends to 4000 ft., although *E. cyaneus* is noted from a 3000 ft. altitude.

EUPHORBIACEÆ is represented by six genera at the higher levels. *Poranthera microphylla* ascends to 6500 ft., *Micrantheum hexandrum* to 4000 ft., *Pseudanthus divaricatissimus* to 5000 ft., *Beyeria viscosa* and *B. opaca*, var. *linearis*, 4000 to 4600 ft., *Phyllanthus thymoides* to 4000 ft., *P. Gunnii* and *Bertya Cunninghamii* ascend to 3600 ft.

URTICACEÆ. — The nettles are represented by two genera, *Australina pusilla* up to 4000 ft., and *Urtica incisa* up to 5000 ft.

CUPULIFERÆ. — The evergreen native beech, *Fagus Cunninghamii*, a fine straight-stemmed tree, ascends to

sub-alpine levels on the western flanks of the Alps, in the Yarra and Talbot valleys, to 3000 ft.

CASUARINEÆ.—Two of the she-oaks, *Casuarina suberosa* and *C. distyla*, are found at altitudes of 3000 to 4000 ft., principally as low shrubs.

SAPINDACEÆ. — Only one genus, with three species, *Dodonæa viscosa*, *D. procumbens*, and *D. boroniæfolia*, ascend to alpine areas, 4000 to 5000 ft.

STACKHOUSIEÆ. — All the species of the genus *Stackhousia* reach alpine habitats, *S. linarifolia* to 4600 ft., *S. viminea* to 5000 ft., and *S. pulvinaris*, in the higher summits, 5000 to 7000 ft.

PORTULACEÆ.—Two of the species of the genus *Claytonia* ascend to the higher levels, *C. pygmæa* to 5000 ft., and *C. australasica*, between 6000 and 7000 ft.

CARYOPHYLLEÆ is well represented by three genera at the higher altitudes, *Stellaria*, by *S. multiflora*, to 4000 ft., *S. pungens* to 5400 ft., *S. flaccida* to 6000 ft.; by *Sagina procumbens* up to 5000 ft., and the endemic *Colobanthus Benthamianus* at 6000 to 7000 ft.; *Scleranthus*, by *S. biflorus* up to 6000 ft.; and the alpine species, *S. mniaroides* between 5000 and 7000 ft.

POLYGONACEÆ. — Several genera are represented by species at the lower sub-alpine levels up to 3000 ft., but only one, *Muehlenbeckia polygonoides*, ascends to 4000 ft.

LEGUMINOSÆ.—22 *Genera.* 76 *Species.*—At the sub-alpine habitats, the well-known *Acacias* are in greatest profusion, comprising, among others, the interesting shrubs *A. vomeriformis*, *A. myrtifolia*, *A. siculiformis*, the first two being more abundant on the open, heathy, stony northern areas, and the latter on the sands and gravels of the different streams. The arboreous species, *A. decurrens*, *A. melanoxylon*, *A. penninervis*, and others, are distributed in open forest lands throughout the area, nowhere gregariously unless in the heads of the gullies with southern aspect. I have noticed that the general form of the species *A. decurrens* and *A. melanoxylon*, when occurring on the stony northern slopes, is essentially different from that which they assume in the

most shaded localities of southern littoral aspect. In the former stations the general form of *A. decurrens*, for instance, is that of a rounded, short, and thick-stemmed tree, frequently attaining a height of eighty feet, smooth barked, and lightly foliaged. The percentage of tannin is also different, those on the dry slopes containing the highest percentage of tan material. *A. alpina* is a low, diffuse species, especially prolific on the highest altitudes.

Nearly the whole of the different species of the genera *Daviesia*, *Pultenæa*, *Bossiæa*, and *Oxylobium* are prolific on dry northern areas, especially the two last. Like the *Acacias*, many species of *Daviesia*, as *D. corymbosa* and *D. ulicina*, are greatly affected by hygrometric conditions in their form and habit, especially *D. latifolia*, which attains the size of a small tree at the 4000 ft. level, north of Mount Bogong, and is of high medicinal value.

Similarly *Pultenæa*, *Muelleri*, and two *Oxylobiums*, *O. alpestre* and *O. ellipticum*, thrive in rich luxuriance in rocky situations amid the snowy regions, their bright yellow and brown flowers giving tone to the landscape. Among *Bossiæas*, *B. bracteosa* and *B. foliosa* are prolific on the high tablelands at similar altitudes. *Hovea longifolia* shows great variations in the form and thickness of its leaves and in the depth of blue and purple colouring of its flowers. In the sub-alpine valleys, *Kennedya monophylla* (native sarsaparilla) flourishes luxuriantly.

ROSACEÆ.—Two genera occur in the alpine and sub-alpine areas, *Rubus gunnianus* and *R. parvifolius*, 4000 to 4500 ft., and *Acæna ovina* and *A. Sanguisorbæ*, both antarctic species, at 5000 to 6000 ft. The European *Alchemilla vulgaris* ascends to 3000 ft.

SAXIFRAGEÆ.—Only one species, *Bauera rubioides*, is seen at the 4000 ft. levels, although *B. sessiliflora* ascends to 3000 ft.

ONAGREÆ.—One species, the ubiquitous *Epilobium tetragonum*, was observed up to 5000 ft.

SALICARIÆ. — The ubiquitous *Lythrum Salicaria* of European type ascends to 4000 ft. in swampy areas.

HALORAGEÆ.—Two species, *Haloragis tetragyna* and *Myriophyllum pedunculatum*, occur up to 4000 ft.

The order MYRTACEÆ is represented not only by the arboreous form of the genus *Eucalyptus*, but also by a number of shrubs of the genera *Callistemon*, *Leptospermum*, *Bæckea*, and others. Of the latter, *Callistemon salignus*, var. *sieberiana*, is met with not only margining the principal streams of 2000 ft., but also ascending to the source runnels intersecting the higher plateaux, where, along with *Bæckea gunniana*, and dwarfed varieties of *Leptospermum* and *Kunzea*, it forms dense undergrowths in the neighbourhood of Sphagnum beds.

Among Eucalypts, the species *E. stellulata*, *E. Gunnii*, and *E. pauciflora* are perhaps the most generally distributed at the higher levels, ascending to the edge of the snowy plateaux as dwarfed, stunted, and gnarled gum-scrub. In the humid shady slopes at lower elevations up to 4000 ft. lofty forms of *E. Globulus* and *E. amygdalina* are met with, while on the opposite side of the ranges or spurs are several species of stringy bark, as *E. macrorhyncha* and *E. capitellata*; the change is in some places so marked as to exhibit a distinct line of demarcation from the blue and white gums to the stringy barks.

On the heathy spurs varieties of *E. piperita* and *E. obliqua* are met with, while on damp flats, and on the rich soil of upland gullies, varieties of *E. stuartiana* are seen.

The economic value of the *Eucalyptus* as timber is so well known that a few remarks on its uses may not be out of place in these notes.

## NOTES ON THE GENUS EUCALYPTUS—ECONOMIC USES.

The term "gum tree," as applied to the *Eucalyptus* vegetation, is distinctly erroneous, as the exudation from the bark is a substance called "kino." Some botanists and chemists have further misnamed this exudation by calling it "gum-resin," or "resin." It is by no means an unimportant product, as, in addition to possessing astringent properties, when boiled in an iron saucepan, it forms a good ink, and will stain leather black. The leaves of the blue gum (*E. Globulus*), when pulverised and mixed

with limewater and copperas (sulphate of iron), give an entire black on cotton and wool, and upon leather give a light coloured tan. The swamp gum (*E. Gunnii*) and the messmate (*E. obliqua*) are similarly worthy of attention. It is also probable that the residue left after the distillation of oil from the leaves may be utilised for tanning purposes.

I may state that the total number of species of *Eucalyptus* in Australia and Tasmania, according to Baron Ferdinand von Mueller's census, is 131; 60 per cent. of which are available as timber trees, the remainder being arboreous or shrubby forms.

In New South Wales there are 48 species, of which 6 per cent. are restricted to the State; and in Victoria there are 35 species, of which 9 per cent. are restricted to the State. Of the 35 Victorian species, 21 occur in the Australian Alps.

*Eucalyptus Globulus* (blue gum).—Baron Ferdinand von Mueller states that within the last twenty years not even the royal oak of England has had such an extensive literature devoted to it as the blue gum; and of these works there are no less than 76, which of themselves would fill a large volume.

The timber is of a rather pale colour, hard, heavy, strong, and durable, more twisted than that of *E. obliqua* (messmate), *E. amygdalina* (white gum), and many other fissile kinds, but not so interlocked as that of *E. rostrata* (red gum), *E. melliodora* (yellow box), and most of the species termed box trees. Its specific gravity varies from ·698 (? 0·968) to 1·108. In transverse strain its strength is about equal to English oak. Its durability is greater than that of the so-called white gum trees and all stringy bark trees. In house-building it is one of our best timbers for joists, studs, rafters, or any other heavy scantlings, and is very largely used for this purpose. It will be seen that the blue gum stands pre-eminent among the woods of all countries in regard to strength, bearing nearly five times the strain of American cedar. There is every reason to believe, therefore, that it will be largely in demand when its valuable properties become better known in European markets.

Besides its timber, it has many other valuable properties. The blue gum has, on the whole, exercised already on regions of the warm temperate zone (where it has been introduced) a greater influence—scenic, industrial, and hygienic—than any other single species of arboreous vegetation ever reared anywhere. Thus (as in Algeria) it has transformed the features of wide, formerly treeless landscapes, has already from its quick growth afforded many places timber and fuel for rapidly increasing settlement, and rendered also many a miasmic locality permanently habitable. To bacteria and other micro-organisms eucalyptus oil proves as fatal as phenic acid. Flesh of any kind is as well preserved by eucalyptus oil as by creosote, while beef sprinkled with it will dry hard without putrefaction. Various parts of the tree yield from 1 lb. 5 oz. to 4 lb. 12 oz. per of pure potash, while valuable oils (eucalyptus) are yielded by the leaves and other parts, which are now largely in use by pharmacopœists generally.

*Eucalyptus amygdalina* (white gum, peppermint tree).—This magnificent tree has a wide range along most of the eastern humid districts of Victoria. Several trees measured gave approximately heights of 400 ft. Mr. Howitt also, in Gippsland, obtained measurement of giant forms up to 410 ft.; but greater heights are recorded. The species must be ranked with the sequoias of California, and the blue gums of Victoria and Tasmania, as among the great giants of the vegetable creation.

It is useful for many kinds of carpenter's work; in drying it does not twist. When stems are straight, as found in forest valleys, the wood splits readily into palings, and this with such facility that in some particular instances a labourer has split 620 palings of 5 ft. length in one day. The timber is not heavy comparatively, as it floats in water, unlike that of many other Eucalypts; it is particularly well adapted for shingles, palings, and rails, and is greatly used in shipbuilding, especially for keelsons and planking.

The ashes of the foliage yield 10 per cent. pearl ash: and from 1000 lb. of fresh leaves, with their stalklets and branches, the yield of eucalyptus oil by far surpasses that

of all other congeners, amounting to as much as 500 oz. or 3·12 per cent., as shown in the following table of yields obtained by Mr. Bosisto:—

*Per 1000 lb. of Leaves, Stalklets, and Branches.*

| | | | |
|---|---|---|---|
| E. viminalis . . | yields | 7 oz. | of eucalyptus oils. |
| E. melliodora . . | ,, | 7 | ,, ,, |
| E. obliqua . . | ,, | 80 | ,, ,, |
| E. Globulus . . | ,, | 120 | ,, ,, |
| E. goniocalyx . . | ,, | 150 | ,, ,, |
| E. leucoxylon . . | ,, | 160 | ,, ,, |
| E. amygdalina . . | ,, | 500 | ,, ,, |

It is mainly on account of this large yield of febrifugal properties that many give preference to the peppermint gum for plantations in any paludal fever region, its only drawback being that it does not grow so rapidly as the blue gum, nor does it so readily accommodate itself to diversity of soils. It is hardier, however, and it has been known to grow to a height of 60 ft. in nine years.

*Eucalyptus viminalis* (white gum, manna tree).—In favourable situations of deep forest glens this tree rises to a very great height. One measured by Mr. D. Boyle was found to be 320 ft. high, and had a stem base 17 ft. in diameter. The timber varies from light to dull brick colour; that from straight stems is employed for shingles, rails, and also rough building material. It is not so durable as the wood of some other kinds of Eucalypts, but is stronger than that of *E. amygdalina* and *E. obliqua.* Boards half an inch thick, sawn from the tall-stemmed smooth varieties grown in moist forest glens, were found to last twice as long as pine boards one inch thick. The stems of this variety are of an almost uniform thickness up to a great height, and mast-like in straightness. When so chosen, the wood is pale and compact, and does not warp. The smaller branching trees on open ridges and plains are noted for exuding a sugary substance called manna, which is considered a great luxury.

*Eucalyptus sieberiana* (white gum-topped stringy bark). —This valuable tree, attaining a height of 200 ft. or more, is common in the alpine and sub-alpine habitats. The trunk is sawn into good timber, and is also used for posts and rails; the wood is recommended for timbering

shafts. It resembles much more that of the blue gum than the stringy bark trees; it is hard, and when seasoned, difficult to cut, but it burns well even when fresh. This wood is of superior quality, light, tough, and elastic. It is used for the swingle trees of buggies, ploughs, etc., but it will not endure underground.

*Eucalyptus Gunnii* (cider gum). — Under favourable conditions this tree attains a height of 250 ft., but usually it is not tall, often crooked or much branched. The wood is hard and very good for many purposes of artisans; it does not split well, but is good for fuel. The tree is noted for yielding a sap of not unpleasant taste, which is converted into a kind of cider, hence the common name.

*Eucalyptus obliqua* (stringy bark, and messmate gum). —This valuable tree is straight stemmed, of rapid growth, attaining a maximum height of 300 ft. It is one of the most important in regard to its abundance, being the most gregarious of all our forest trees, and, on account of the ease with which the wood is worked, it supplies a large proportion of the ordinary sawn hard timber for rough building purposes. Being very fissile, it is also extensively split into fence rails, palings, and shingles; it is light coloured. The specific gravity of the wood varies from 0·809 to 0·990, or from 50 to 60½ lb. per cubic foot. Mr. F. Campbell found the tensile strength per square inch to be equal to a pressure of 8200 to 8500 lb. Baron Ferdinand von Mueller has shown that the bark is suitable for the manufacture of paper, not only for packing, mill- and paste-boards, but also for printing and writing. The utility of this tree is therefore very great.

RHAMNACEÆ.—*Represented by 3 Genera at sub-alpine habitats.*—*Pomaderris apetala*, which ascends in shrubby form to 4000 ft., forms a dense undergrowth at the lower levels, straight stems attaining a height of from 15 to 20 ft. *P. elachophylla*, *P. elliptica*, and *P. phylicifolia* ascend to 3000 ft.

*Cryptandra amara* ascends to 4000 ft., a pretty white-flowered shrub.

*Colletia pubescens*, a spiny shrub, ascends to 3000 ft.

ARALIACEÆ.—One species of *Panax*, *P. sambucifolius*, of very variable habit, ascends to 4000 ft. The leaves in the sub-alpine form are narrower than that in the lowlands, and more pinnate.

UMBELLIFERÆ.—Some of the alpine species, such as *Aciphylla glacialis*, *Oreomyrrhis pulvinifica*, *O. andicola*, *Huanaca hydrocotylea*, *Azorella cuneifolia*, and *A. dichopetala*, and also *Didiscus humilis*, which flourish best between elevations of 5000 to 7000 ft., are very characteristic. *A. glacialis* is readily eaten by stock, and may become available for culinary purposes by cultivation. A *Seseli*, *S. harveyanus*, is also abundant between 5000 and 6000 ft.

SANTALACEÆ.—In addition to the well-known species, *Exocarpos cupressiformis* (native cherry tree), which ascends to sub-alpine levels of 4000 ft., several shrubby species, with pleasantly acidulous berries, as *E. stricta*, *E. humifusa* (of Polynesian affinities), and *E. nana*, ascend, along with *Leptomeria aphylla*, *Omphacomeria acerba*, and *Choretrum lateriflorum*, 4000 to 5000 ft. altitudes.

In the PROTEACEÆ, an order whose maximum of species is reached in Western Australia, we have a few apparently endemic forms, as *Grevillea miqueliana*, *G. alpina*, etc. The valuable notes given by the Government botanist in his examination of the "Vegetable Fossils of the Auriferous Drifts of Victoria" (p. 10), appear to indicate some resemblance between the existing forms of tropical Grevilleas, and the vegetation of the Pliocene era. It is to be hoped that further palæontological researches may yet be available for correlation purposes, enabling the pre-existing flora to be more satisfactorily compared with the present, and by this means to trace out the successive changes which have taken place, not only in the surface configuration, but in the flora and fauna of our present alpine regions. One species of Proteaceæ herein referred to, viz. *Persoonia juniperina*, is suggested by Professor Tate, of

South Australia, as a probable survival of an alpine flora of Pliocene date.[1]

Another species, the handsome *Orites lancifolia*, is an inhabitant, almost exceptionally, of the higher and colder regions, not descending in this area below 3000 ft.

Several of the *Hakeas* and *Grevilleas* form small trees at the sub-alpine habitats, but become dwarfed to almost prostrate shrubs at the higher altitudes.

The *Banksias* do not thrive above 4000 ft. altitude. *Telopea* (the waratah) is restricted to the eastern valley of the Snowy River (coast range).

THYMELEÆ.—The most extensive genus here represented is that of *Pimelea*, containing several species known as possessing valuable industrial properties, as *P. axiflora* and others, which yield a fine brown dye, and superior bast of great tenacity, and the more compact bush *P. ligustrina*, of medicinal value,—the former more abundant on shady hillsides at lower levels, and the latter on the wooded depressions on the high tablelands up to 5000 ft. Another species, *P. alpina*, is common as a diffuse small leaved form at the higher altitudes up to 7000 ft. in open situations.

RUBIACEÆ.—Two genera, *Coprosma* and *Asperula*, are represented by species, *C. hirtella* and *A. oligantha*, at the higher levels, 4000 to 6000 ft.

CAPRIFOLIACEÆ.—The only species of the native elderberry, *Sambucus gaudichaudiana*, ascends to 5000 ft., and in the form and thickness of leaves and general habit differs considerably from the lowland form.

COMPOSITÆ.—25 *Genera*. 74 *Species*.—The extensive order Compositæ next claims attention. Bentham remarks: "The Compositæ are the most extensive of flowering plants, and represented in every quarter of the globe in every variety of station," and that there are five

[1] Trans. Roy. Soc., S.A., "Notes on the Proteaceæ of the Australian Alps," by J. Stirling.

hundred species indigenous to Australia. I have noted great variation in the growth of many composite herbs in the Australian Alps during different seasons, sports being abundant in dry seasons, and the reversion to foliaceous growths very remarkable. The florets in *Microseris Forsteri*, for instance, becoming pedicellate and assuming the form of an Umbellifer. The genera *Brachycome*, *Aster*, *Senecio*, and *Helychrysum* are most abundant; *Brachycome* is represented by the herbaceous species *B. decipiens*, *B. diversifolia*, etc., which yield a fine carpeting of flowers on the open grassy ridges and flats during early summer, ascending to the alpine regions at the higher plateaux 6000 ft. elevation. *B. nivalis* occurs at the highest elevations up to 7000 ft.

*Aster* includes, among other arboreous forms, the ever-scented native musk (*A. argophyllus*), which attains its greatest luxuriance among the deeply vegetated and shaded glens on the sub-alpine littoral slopes where humidity prevails. Shrubs, as *A. stellulatus*, *A. myrsinoides*, are more evenly distributed in open northern areas along the banks of streams, although the latter is represented by dwarfed forms on the lower ridges of the higher plateaux. Such herbs as *A. Celmisia*, which gives a noticeable character to the physiognomy of the alpine vegetation, *Gnaphalium alpigenum*, *Erigeron pappochromus*, *Antennaria uniceps*, and *Leontopodium latipes*, are apparently restricted to the grassy alpine stations where the hygrometric conditions are suitable to their growth; and shrubs, as *A. Muelleri*, *A. alpicola*, and *A. megalophyllus*, are common at 4000 ft. elevation.

The Helichrysums, like the Brachycomes, are principally herbaceous, represented both by species on the lower sunny areas of undulating country, as *H. semipapposum*, *H. apiculatum*, and by the larger-flowered *H. bracteatum* (syn. *H. lucidum*) on the higher tablelands, and, as remarked in a previous paper, "covering these highlands with fields of bright golden yellow flowers, giving a distinctive character to the landscape; while at similar elevations the diffuse *H. baccharoides* covers acres with dense undergrowth."

The new species discovered during the visit of the

Australian Association to the Alps, *H. Stirlingii*, is restricted to 4000 ft. elevations round Mt. Hotham.

At lower levels, 2000 to 3000 ft., along the courses of some of the principal streams, the shrubby species *H. rosmarinifolium* is met with, a var. *thyrsoides* ascending to 5000 ft., which, when drying, emits a delightful fragrance.

*Helipterum anthemoides* flourishes best at the higher elevations, and an alpine variety of *H. icanum*, var. *auriceps*.

The remarkable variation in the alpine form of *Craspedia Richea* is noteworthy, the alpine variety being very distinct from the lowland form.

*Cotula alpina* and *Abrotanella nivigena*, together with *Senecio pectinatus*, flourish at the higher elevations. *S. Bedfordii* grows as a tree at the sub-alpine habitats up to 4500 ft.

CAMPANULACEÆ. — Only two genera are represented at the higher levels by herbaceous species, *Lobelia gelida*, and the ubiquitous *Wahlenbergia gracilis*, up to 6000 ft.; the latter has more violet-blue coloured flowers than the lowland form, the leaves are more tomentose, and the stem shorter.

CANDOLLEACEÆ.—Two very marked species of *Stylidium* occur, one, *S. graminifolia*, is very luxuriant at 4000 to 5000 ft., and the other, *S. serrulata*, up to 6000 ft. The sensitive stigma of these species is very characteristic.

GOODENIACEÆ.—5 *Genera*. 11 *Species*. *Mostly sub-alpine.* —This order is only represented at the higher levels by two species of the genus *Velleya*, viz. *V. paradoxa* and *V. montana*, which ascend to 6000 ft. elevation.

The var. *cordifolia* of *Goodenia hederacea* does not ascend above 3500 ft., while the species *G. ovata*, plentiful and gregarious at the lower sub-alpine areas of 2000 ft., only ascends to an elevation of 3000 ft.

GENTIANEÆ is also represented by two genera, the bright pink-flowered *Erythræa australis* and the white-flowered *Gentiana saxosa*, up to 6000 ft., the latter a very prominent feature in the summer pasturages on the tablelands.

PLANTAGINEÆ. — One species, *Plantago stellaris*, is common between 5000 and 7000 ft., especially at the higher levels.

SOLANACEÆ.—Only one *Solanum*, *S. vescum*, ascends to 4000 ft. levels.

The extensively distributed order SCROPHULARINEÆ is represented principally by herbs and under-shrubs of the genera *Euphrasia* and *Veronica*. Among the former the species *E. Brownii*, which ascends to 6500 ft., and *E. antarctica*, cover the grassy highlands during mid-summer with their beautiful yellow flowers, whilst on the grassy ridges at lower levels *E. speciosa* predominates along with *E. scabra*.

Among *Veronicas*, *V. Derwentia* is common on shaded hillsides, *V. perfoliata* on rocky bluffs up to 5000 ft., and *V. gracilis* on damp grassy flats at the lower levels up to 3000 ft. *V. densifolia* ascends to 5000 ft., and *V. serpyllifolia* between 5000 and 6000 ft.

LENTIBULARIEÆ.—On damp flats the lowly *Utricularia dichotoma* flourishes between 5000 and 6000 ft.

ASPERIFOLIÆ. — *Myosotis suaveolens* and *Cynoglossum suaveolens* ascend to 5000 ft.

Among the LABIATÆ, an order consisting principally of herbs and shrubs, occurs the perhaps solitary arboreous form *Prostanthera lasianthos*, an inhabitant of most densely vegetated gullies of littoral aspect. At sub-alpine altitudes of 2000 to 4000 ft. an apparently alpine species, *P. cuneata*, may be found growing from the crevices of rocks at the highest elevations.

The ubiquitous *Ajuga australis* ascends to 5000 ft.

Next in importance are the hardy "native heaths" or EPACRIDEÆ. The plants of this order, although numerically less as regards species than the Compositæ or Leguminosæ, are still, owing to their extensive distribution over the whole area, more frequently met

with, the principal genus being *Styphelia*, with which Baron Ferdinand von Mueller has now included a number of previously formed separate genera.[1]

The species of *Styphelia* herein referred to consist principally of shrubs and undershrubs of heath-like form, from the robust and erect *S. lanceolata*, *S. scoparia*, etc.,—which attain their most luxurious growth on the wooded sub-alpine ranges near and on the Great Dividing Range, where condensation and precipitation of vapour is greatest and most continuous,—to the decumbent and diffuse *S. serrulata*, flourishing on the drier stony northern areas at lower elevations. At the higher levels *S. collina* and *S. glacialis*, flourish between 5000 and 6000 ft.; *S. montana* ascends to 5000 ft.

Another genus, *Epacris*, is represented on sandy soils, at the sub-alpine habitats, by the lovely crimson and white *E. impressa*; and struggling to higher elevations along courses of streams are seen dwarfed forms of the otherwise erect *E. heteronema* of lower levels; while abundant on the damp upland marsh lands are seen varieties of *E. microphylla*; and on the stony crests of ridges the alpine species *E. paludosa*, *E. petrophila*, and *E. serpyllifolia*; and among the Sphagnum beds, *Richea Gunnii*, between 4000 and 6500 ft.

ERICACEÆ.—This distinctly European order, especially characterised by the genus *Erica* in the British Highlands, is only represented by two shrubs in the Australian Alps. The snow bush, with fine large leaves and beautiful snow-white berries, *Gaultiera hispida*, and *Wittsteinia vacciniacea*, with pink and white berries; these species are not met with below 4000 ft., and ascend to 6000 ft. levels.

The ORCHIDEÆ are not at all prevalent at the higher levels; I have not observed any above 5000 ft. *Diuris pedunculata* ascends to these elevations.

Many of the species occur at the sub-alpine habitats, between 2000 and 4000 ft. *Dipodium punctatum* is prolific at 4000 ft., along with *Caladenia Patersoni* and *Glossodia minor*.

[1] "Systematic Census of the Plants of Australia," 1883, p. 105.

Amaryllideæ (Hypoxideæ) is represented by one species, *Hypoxis hygrometrica*, at the 5000 ft. altitudes.

Liliaceæ.—The genus *Dianella* is represented by the species *D. tasmanica*, which is luxuriant at 5000 ft., and ascends to 6000 ft. *Astelia alpina* also occurs between 4000 and 5000 ft.

The little spring flower *Wurmbea dioica* is common on sub-alpine flats up to 4000 ft., along with *Cæsia vittata* and *Stypandra glauca*, and also the small flat-leaved *Xerotes longifolia*, used by the aborigines for making baskets.

None of the grass trees, such as *Xanthorrhœa australis*, ascend higher than 3000 ft.

Juncaceæ, the very ubiquitous *Luzula campestris*, ascends to 5000 ft., *Juncus falcatus* to 5000 ft., and several others to 4000 ft., as *J. bufonius*, *J. communis*, and *J. prismatocarpus*, up to 4000 ft.

Among the Cyperaceæ, however, there appear to be a few species of the extensive genus *Carex* which are restricted to the alpine regions of Victoria and Tasmania, as *C. acicularis*, between 4000 and 6000 ft.; *C. Buxbaumii*, *C. gunniana*, at 5000 ft., etc.; although some of the species are represented in Europe and North America, and also in north Asia.

*Carex Pseudo-Cyperus* ascends to 5000 ft., along with *C. canescens*. *Cyperus lucidus* is common up to 4000 ft.; the diminutive *Oreobolus Pumilio* is found at the higher altitudes between 6000 and 7000 ft.; *Carpha alpina* between 5000 and 6000 ft. In *Lepidosperma*, *L. concavum*, and *L. lineare* ascend to 4000 ft.; *Uncinia tenella* forms tufts between 3000 and 4000 ft.

The important order Gramineæ which, as regards number of species, stands next to the Leguminosæ throughout the world, is here represented by 19 genera and 38 species, principally, as regards number of species, by the genera *Agrostis*, 5; *Danthonia*, 4; *Poa*, 4; *Hierochloe*, 3; *Stipa*, 3; *Panicum*, 3; *Andropogon*, 2; *Ehrharta*, 2; *Agropyron*, 2; and others; but in respect to territorial

range of single species none are more extensively distributed than the well-known "Kangaroo grass," *Anthistiria ciliata.* The *Poas* are the tallest grasses to be met with in these regions. Culms of *P. dives* are frequently seen to attain a height of twelve feet in shaded hillsides, the whole plant being succulent and nutritious, and may hereafter repay cultivation.

All the local *Danthonias* at the higher levels, and the *Festucas* at the sub-alpine habitats, are good fodder grasses. A species of *Trisetum, T. subspicatum,* is apparently restricted to the higher mountain regions of Victoria, New South Wales, and Tasmania.

The genera *Anthistiria, Danthonia, Agrostis, Trisetum, Agropyron, Echinopogon, Hierochloe,* are represented by species above the 5000 ft. altitude.

There are 9 genera and 22 species growing at elevations between 5000 and 7000 ft.

## CONIFERÆ.

The Conifers are only represented by a low dwarfed shrub at the higher levels, *Nageia alpina,* restricted to 5000 to 6000 ft.; in the valley of the Snowy River, trees of Snowy River pine, *Callitris verrucosa,* ascend to 3000 ft.

## FILICES (FERNS).

23 *Genera.* 51 *Species.*

The genera *Lomaria, Pteris, Asplenium, Cheilanthus,* and *Grammitis* are represented by species at the higher altitudes over 5000 to 7000 ft. *Botrychium lunaria* and *Lomaria alpina* occur at the highest elevations.

The genera richest in species are—

| | |
|---|---|
| Pteris . . . . . . | 9 species. |
| Asplenium . . . . . | 6 " |
| Lomaria . . . . . | 5 " |
| Gleichenia . . . . . | 4 " |
| Polypodium . . . . . | 4 " |
| Dicksonia . . . . . | 3 " |
| Aspidium . . . . . | 3 " |

The tree-ferns, *Dicksonia antarctica*, reach a height in humid gullies of 50 ft., but do not ascend higher than 4500 ft.

The maximum number of species flourish between 2000 and 4000 ft. in the humid gullies and on the rocky spurs.

There are 10 genera and 8 identical species common to Arran (Scotland) and the Australian Alps.

### MUSCI (MOSSES).

Of the 70 genera and 170 species of mosses occurring in the Australian Alps, a number are identical with those of Stewart Island (south of New Zealand), and 31 genera and 10 species are common to the Australian Alps and Arran (Scotland). The genera and species common to the Australian Alps and Arran are marked with an asterisk.

The genera containing more than four species over the whole area at all elevations are as follows:—

| | | | |
|---|---|---|---|
| Bryum . . . | 16 species. | Fissidens . . . | 7 species. |
| Grimmia . . . | 12 ,, | Trichostomum . . | 6 ,, |
| Rhyncostegium . | 9 ,, | Bartramia . . . | 5 ,, |
| Barbula . . . | 7 ,, | Entosthodon . . | 5 ,, |

The genera represented by species at the highest elevations between 5000 and 7000 ft. are—

| | | | |
|---|---|---|---|
| Bartramia . . . | 5 species. | Polytrichum . . | 1 species. |
| Zygodon . . . | 3 ,, | Brachythecium . . | 1 ,, |
| Breutelia . . . | 2 ,, | Dicranella . . . | 1 ,, |
| Bryum . . . | 2 ,, | Blindia . . . | 1 ,, |
| Campylopus . . | 2 ,, | Sphagnum . . . | 1 ,, |
| Grimmia . . . | 2 ,, | Tortula . . . | 1 ,, |
| Philonotis . . . | 1 ,, | Encalyptra . . | 1 ,, |
| Meesea . . . | 1 ,, | Apalodium . . | 1 ,, |
| Atrichum . . . | 1 ,, | Hypnum . . . | 1 ,, |
| Pogonatum . . | 1 ,, | | |

Thus, while the genera *Bryum* and *Grimmia* contain the greatest number of species at all altitudes, *Bartramia* and *Zygodon* have the most species in the highest altitudes.

### LICHENES.

*Represented in the Australian Alps between* 2000 *and* 7000 *ft. levels by* 47 *Genera and* 95 *Species.*

Most of the species enumerated are common to the sub-alpine areas and the adjacent lowlands, the greatest

number on the southern or south-eastern slopes and valleys which trend towards the Gippsland Lakes or the Southern Ocean.

The genera richest in species are — *Parmelia*, 14; *Cladonia*, 14; *Calicium*, 13; *Parmelia* and *Peltigera* being abundant in the Sphagnum beds of Mount Bogong, 6000 to 6500 ft.

During the visit of the Australasian Association to the Australian Alps in 1890, the Rev. Thomas M. Wilson collected 38 species, representing 17 genera from one locality alone, viz. from the slopes and summit of Mount Hotham, 6100 ft., and in the adjacent Ovens Valley to the north—*Cladonia*, 6 species; *Cladina*, 1; *Stereocaulon*, 3; *Siphula*, 1; *Usnea*, 1; *Neuropogon*, 1; *Peltigera*, 1; *Sticta*, 1; *Parmelia*, 4; *Theloschistes*, 1; *Umbilicaria*, 2; *Lecanora*, 4; *Placodium*, 1; *Urceolaria*, 1; *Bruellia*, 5: and in the Ovens Valley—*Calicium*, 4; *Pertusaria*, 1; *Heterothecium*, 1; *Verrucaria*, 1.

There are no less than 22 genera and 16 identical species common to Arran and the Australian Alps.

## FUNGI AND MICRO-FUNGI.

Of the 20 genera and 26 species of micro-fungi collected between 2000 and 6000 ft. elevation, a number are exotic; no less than 15 genera and 7 identical species occur in Arran. The genera containing the greatest number of species are—

| | | | |
|---|---|---|---|
| Agaricus . . . . | 6 species. | Puccinia . . . . | 2 species. |
| Polyporus . . . . | 5 „ | Isaria . . . . | 2 „ |
| Stereum . . . . | 3 „ | Uredo . . . . | 2 „ |

All the other genera were represented by only one species.

## COMPARISON WITH A BRITISH AREA.

During a recent visit to Arran and the Clyde Valley, I was able to compare a list of the plants published in the British Association 1901 Handbook, as having been recorded from that island, with those occurring in the Australian Alps.

I found that there were no less than 36 natural orders,

and 151 genera common to both areas, and 68 identical species, viz.—

| | | | |
|---|---|---|---|
| 70 genera of | Phanerogams (including grasses, etc.) | 27 identical species. | |
| 10 „ | Ferns . . . . | 8 | „ |
| 2 „ | Lycopodiums . . . | 2 | „ |
| 1 genus of | Sphagnum . . . . | 1 | „ |
| 31 genera of | Mosses . . . . | 10 | „ |
| 22 „ | Lichens . . . . | 16 | „ |
| 15 „ | Fungi and micro-fungi . . | 4 | „ |

A number of these plants, particularly herbaceous species, are evidently immigrants to the Australian area, others are apparently common to both areas.

I have marked with an asterisk (*), on the following Census, the genera and species common to both localities.

## CENSUS OF THE FLORA OF THE AUSTRALIAN ALPS.

### ANGIOSPERMÆ.

#### DICOTYLEDONES.

#### CHORIPETALÆ HYPOGYNÆ.

##### RANUNCULACEÆ.

*Clematis.**

C. aristata (Br.). T., N.S.W., S.A , Q., N.A.

*Var.* coriacea ascends in sub-alpine gullies to an altitude of 4600 ft.

C. microphylla (Br.). T., N.S.W., S.A., Q., W.A.

*Var.* leptophylla ascends to 3000 ft. in southern slopes.

*Myosurus.*

M. minimus (Linn.). N.S.W., S.A.

Ascends to 3000 ft.

*Ranunculus.**

R. aquatilis (Dod.). T., S.A.

Common on sub-alpine streams, and near marshes up to 2000 ft.

R. Millani (F. v. M.). N.S.W.

Endemic on Mts. Kosciusko and Bogong at elevations of 6000 to 7000 ft.

R. anemoneus (F. v. M.). N.S.W.

Endemic to Mt. Kosciusko and adjoining peaks, also on Mt. Bogong, etc., 6000 to 7000 ft.

R. gunnianus (Hook.). T., N.S.W.

Alpine, endemic to Australian Alps and Tasmania, 4500 to 7000 ft.

R. Lappaceus (Sm.). T., N.S.W., S.A., Q., W.A., N.Z.

*Var.* Plebeius subsericeus at the higher levels, 6000 ft., petals rich yellow.

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*Note.*—T. Tasmania.
N.S.W. New South Wales.
S.A. South Australia.
Q. Queensland.
W.A. Western Australia.
N.A. Northern Australia.
N.Z. New Zealand.

*Ranunculus* continued—*

R. Muelleri (Benth.). N.S.W.
Endemic to Mt. Kosciusko.

R. rivularis (Bks. and Sol.). T., N.S.W., S.A., Q.
Ascends to 6000 ft.

R. hirtus (Bks. and Sol.). N.S.W., Q., W.A., N.Z.
Ascends to 3000 ft.

R. parviflorus (Linn.). T., N.SW., S.A., Q.
Ascends to 3000 ft. on northern valleys.

*Caltha.**

C. introloba (F. v. M.). T., N.S.W.
Endemic to Australian Alps and Tasmania. Mts. Kosciusko, Bogong, Hotham, etc., 5000 to 7000 ft.

### DILLENIACEÆ.

*Hibbertia.*

H. densiflora (F. v. M.). T., N.S.W., S.A.
Ascends to 2000 ft.

H. stricta (Br.). T., N.S.W., S.A., Q., W.A.
*Var.* calycina ascends to 3000 ft.

H. Billardieri (F. v. M.). T., N.S.W., S.A., Q.
*Var.* ovata ascends to 2000 ft., Tambo Valley.

H. serpyllifolia (Br.). T., N.S.W.
Ascends to 4600 ft.

H. pedunculata (Br.). N.S.W.
Ascends to 3600 ft. on northern slopes of Mt. Kosciusko.

H. linearis (Br.). N.S.W., Q.
Ascends on northern slopes to 3600 ft.

H. diffusa (Br.). N.S.W.
Similar aspect to H. linearis.

H. dentata (Br.). N.S.W., Q.
3000 ft., Snowy River valley.

### MAGNOLIACEÆ.

*Drimys.*

D. aromatica (F. v. M.). T., N.S.W.
Sub-alpine. Small tree at 2000 to 4000 ft.; at higher levels, 5000 to 6000 ft., low diffuse shrub (thick leaves).

### MONIMIEÆ.

*Atherosperma.*

A. moschatum (Lab.). T., N.S.W.
Ascends in deep gullies to 4600 ft.

*Hedycarya.*

H. Cunninghami (Tul.). N.S.W., Q.
Ascends in moist gullies of southern slopes to 4600 ft.; a fine small tree.

### LAURACEÆ.

*Cassytha.*

C. glabella (Br.). T., N.S.W., S.A., Q., W.A.
Covers scrub at 4000 ft. elevation.

C. pubescens (Br.). T., N.S.W., S.A., Q., W.A.

C. melantha (Br.). T., N.S.W., S.A., W.A.
Ascends to 5000 ft.

CRUCIFERÆ.

*Barbarea.**
B. vulgaris* (Br.). T., N.S.W., N.Z.
(*Var.* australis.)
On banks of streams up to 3500 ft.

*Arabis.**
A. glabra (Crantz.). N.S.W.
Ascends on northern streams up to 4600 ft.

*Cardamine.**
C. dictyosperma (H.). T., N.S.W.
Ascends to 5000 ft.
C. hirsuta* (Linn.). T., N.S.W., S.A., Q., W.A.
Ubiquitous all over the Alps up to 7000 ft.

*Erysimum.**
E. blennodioides (F. v. M.). N.S.W., S.A., Q.
(Blennodia alpestris.)
Ascends to 2000 ft. on northern streams.
E. capsellinum (F. v. M.) N.S.W.
Ascends to 6500 ft. on Mt. Bogong.

*Capsella.*
C. antipoda (F. v. M.). T.
Ascends to 2000 ft.
C. Bursa-pastoris.*

VIOLACEÆ.

*Viola.**
V. betonicifolia (Sm.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.
V. hederacea (Lab.). T., N.S.W., S.A., Q.
Mt. Bogong slopes to 5000 ft.
V. caleyana (G. Don.). T., N.S.W.
Mt. Bogong to 6500 ft.

*Hybanthus.*
H. filiformis (F. v. M.). N.S.W., Q.
Ascends to 4000 ft. on southern ridges.

*Hymenanthera.*
H. Banksii (F. v. M.). T., N.S.W.
Ascends in stunted spinous form to 6000 ft. at Mt. Bogong (*var.* angustifolia).

PITTOSPOREÆ.

*Pittosporum.*
P. undulatum (And.). T., N.S.W., Q.
On southern valleys at 2000 ft.
P. revolutum (Aiton). N.S.W., Q.
Ascends to 3000 ft.
P. bicolor (H.) T., N.S.W.
Common on Main Dividing Range at 4000 ft.; ascends to 4600 ft. on high ridges.

*Bursaria.*
B. spinosa (Cav.). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 4000 ft.

*Marianthus.*
M. procumbens. T., N.S.W., Q.
Ascends to 3000 ft.
M. bignoniaceus (F. v. M.). S.A.
Ascends to 3000 ft.

*Billardiera.*

B. longiflora (Lab.). T., N.S.W.
Ascends to 4000 ft.

B. scandens (Sm.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

B. cymosa (F. v. M.) N.S.W., S.A.
Ascends to 2000 ft. on southern ridges.

*Cheiranthera.**

C. linearis (Cunn.). N.S.W., S.A., Q.
Ascends on northern ridges to 3000 ft.

DROSERACEÆ.

*Drosera.**

D. Arcturi (H.). N.S.W., S.A., W.A., N.Z.
Sub-alpine; summits of Mts. Hotham, Bogong, Kosciusko, at altitudes of 6000 to 7000 ft.

D. spathulata (Lab.). T., N.S.W., S.A., Q., N.Z., I.
Ascends to 3000 ft.

D. auriculata (Back). T., N.S.W., S.A.
Ascends to 4000 ft.

D. peltata (Sm.). T., N.S.W., S.A., Q., N.Z.
Ascends to 3000 ft.

HYPERICINEÆ.

*Hypericum.**

H. japonicum (Thun). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 5000 ft. Gramineum, a well-marked variety, occurs.

POLYGALEÆ.

*Polygala.**

P. sibirica (Linn.). N.S.W., Q.
Ascends to 3000 ft.

*Comesperma.*

C. volubile (Lab.). T., N.S.W., S.A., Q., W.A.
Ascends 3000 to 4000 ft.

C. retusum (Lab.). T., N.S.W., Q.
Common at higher altitudes, between 5000 and 6000 ft.

C. ericinum (DC.). T., N.S.W., Q.
Ascends to 4000 ft.

TREMANDREÆ.

*Tetratheca.*

T. ciliata (Lind). T., S.A
Ascends to 3000 ft.

T. pilosa. T.
Ascends to 2500 ft.

RUTACEÆ.

*Zieria.*

Z. Smithii (And.). N.S.W., Q.
Ascends to 4800 ft. *Var.* macrophylla common between 3000 and 4000 ft.

*Boronia.*

B. algida (F. v. M.). N.S.W.
Common on summits of higher Alps up to 7000 ft.; Mt. Bogong, 6500 ft.

*Boronia—continued—*

B. pilosa (Lab.). T.

Between 4000 and 6000 ft.

B. polygalifolia (Sm.). T., N.S.W., S.A., Q.

All over Alps up to 6000 ft. *Var.* anemonifolia also occurs, and a *var.* resembling B. pimata is sometimes met with.

*Eriostemon.*

E. phylicifolius (F. v. M.).

Common near summits of Mts. Cobberas, Bogong, and Hotham, between 4000 and 6000 ft.

E. umbellatus (Turcz.). N.S.W.

This is considered as a lowland form of E. phylicifolius; it ascends to 2000 ft.

E. lamprophyllus (F. v. M.). N.S.W.

Ascends to 6000 ft.

E. ozothamnoides (F. v. M.). N.S.W.

Ascends in northern valleys to 6000 ft.

E. lepidotus (Spreng.). A *var.* N.S.W., S.A., Q.

E. alpinus (F. v. M.). N.S.W.

Common between 5000 and 6500 ft.; Mt. Bogong, 6500 ft.

E. ovatifolius (F. v. M.). N.S.W.

Occurs between 4600 and 7000 ft. on the higher areas of Mt. Bogong.

E. correifolius (F. v. M.). N.S.W.

Between 3000 and 6000 ft.; syn. of Asterolasia Muellerii.

E. pleurandroides.

On stony northern slopes at 3000 ft.

E. trymalioides (F. v. M.). N.S.W.

Near summits of higher Alps, above 5000 to 7000 ft.; Mt. Bogong, 6500 ft.

E. Crowei (F. v. M.). N.S.W., Q.

Ascends to 4000 ft.

E. trachyphyllus (F. v. M.). N.S.W.

On southern valleys up to 4000 ft.

E. myoporoides (DC.). N.S.W., Q.

Ascends to 4000 ft.

*Correa.*

C. æmula (F. v. M.). S.A.

Ascends to 3600 ft.

C. alba (And.). T., N.S.W., S.A.

Ascends to 2000 ft. on southern slopes.

C. speciosa (And.). T., N.S.W., S.A., Q.

Ascends to 3000 ft.

C. lawrenciana (H.). T., N.S.W.

Common up to 5000 ft. altitudes; a very prolific flowering shrub.

## ZYGOPHYLLEÆ.

*Zygophyllum.*

Z. glaucescens (F. v. M.). T., N.S.W., S.A., Q.

Ascends to 2000 ft.

## LINEÆ.

*Linum.**

L. marginale (Cunn.). T., N.S.W., S.A., Q., W.A.

Very robust at 3000 to 4000 ft.; ascends to 5000 feet. (Native flax.)

GERANIACEÆ.

*Geranium.**
G. carolinianum (Linn.). T., N.S.W., S.A., Q., W.A.
Ascends to 4000 ft.
G. sessiliflorum (Cav.). T., N.S.W.
Ascends to 5000 ft.
*Pelargonium.*
P. australe (Willd.). T., N.S.W., S.A., Q., W.A., S.Af.
Ascends to 8000 ft.; Mt. Bogong, 6000 ft.
*Oxalis.**
O. magellanica (Fors.). T., N.Z.
Ascends to 5400 ft.
O. corniculata (Linn.). T., N.S.W., S.A., Q., W.A.
Ubiquitous; ascends to 3000 ft., common; found on Mt. Bogong to 6000 ft.

MALVACEÆ.

*Plagianthus.*
P. pulchellus (Gray). T., N.S.W.
Ascends to 3000 ft.
*Howittia.*
H. trilocularis (F. v. M.). N.S.W., S.A.
On southern valleys of Snowy River ascends to 2000 ft.

STERCULIACEÆ.

*Commersonia.*
C. dasyphylla (And.). N.S.W., Q.
Ascends to 4500 ft.
*Lasiopetalum.*
L. dasyphyllum (Sieb.). T., N.S.W.
Ascends to 4000 ft.
*Brachychiton.*
B. populneum (Br.).
Ascends to 3000 ft. (Carrajung.)

TILIACEÆ.

*Elæocarpus.*
E. holopetalus (F. v. M.). N.S.W.
Ascends to 4000 ft.
E. cyaneus (Aiton). T., N.S.W., Q.
Ascends to 3000 ft.

EUPHORBIACEÆ.

*Poranthera.*
P. microphylla (Bron.). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 6500 ft., Mt. Bogong.
*Micrantheum.*
M. hexandrum (H.). T., N.S.W., S.A.
Ascends to 4000 ft.
*Pseudanthus.*
P. divaricatissimus (Ben.). N.S.W.
Ascends to 5000 ft.

*Beyeria.*
B. viscosa (Miq.). T., N.S.W., S.A., Q., W.A.
Ascends to 4600 ft.
B. opaca (F. v. M.). T., N.S.W., S.A.
A *var.* linearis ascends to 4000 ft.

*Ricinocarpus.*
R. pinifolius (Desfon.). T., N.S.W., Q.
Ascends to 2000 ft., Snowy River valleys.

*Bertya.*
B. Cunninghamii (Plan.). N.S.W.
Ascends to 3600 ft.

*Amperea.*
A. spartioides (Bron.). T., N.S.W., S.A., Q.
Ascends to 2000 ft.

*Phyllanthus.*
P. thymoides (Sieb.). N.S.W., S.A.
Ascends to 4000 ft.
P. Gunnii (H.). T., N.S.W., S.A.
Ascends to 3000 ft.

*Adriana.*
A. tomentosa (Gaud.). N.S.W., S.A., Q., W.A., N.A.
Ascends to 2000 ft.

URTICACEÆ.

*Australina.*
A. pusilla (Gaud.). T., N.S.W.
Ascends to 4000 ft.

*Urtica.**
U. incisa (Poir.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.

CUPULIFERÆ.

*Fagus.**
F. Cunninghamii (H.). T.
Ascends to 3000 ft. in southern and western gullies.

CASUARINEÆ.

*Casuarina.*
C. quadrivalvis (Lab.). T., N.S.W., S.A.
Ascends to 2000 ft.
C. suberosa (O. & Die.). T., N.S.W., Q.
Ascends to 4000 ft.
C. distyla (Ven.). T., N.S.W., S.A., W.A.
Ascends to 3000 ft.

VINIFERÆ.

*Vitis.*
V. hypoglauca (F. v. M.). N.S.W., Q.
Ascends to 2000 ft.

SAPINDACEÆ.

*Dodonæa.*
D. viscosa (Linn.). T., N.S.W., S.A., Q., W.A., N.A., N.Z.
Ascends to 4000 ft.
D. procumbens (F. v. M.). N.S.W., S.A.
Ascends to 5000 ft.
D. boroniæfolia (Don.). N.S.W., S.A., Q.
Ascends to 4000 ft.

STACKHOUSIEÆ.

*Stackhousia.*

S. pulvinaris (F. v. M.). T., N.S.W.

Summits of higher Alps between 5000 and 7000 ft.

S. linarifolia (Cun.). T., N.S.W., S.A., Q.

Ascends to 4600 ft.

S. viminea (Sm.). N.S.W., Q., N.A.

Ascends to 5000 ft.

PORTULACEÆ.

*Claytonia.**

C. pygmæa (F. v. M.). N.S.W., S.A., W.A.

Ascends to 5000 ft.

C. australasica (H.). T., N.S.W., S.A., W.A.

Ascends to 7000 ft.; Mt. Bogong, 6500 ft.

C. calyptrata (F. v. M.). T., N.S.W., S.A., Q., W.A.

Ascends to 2000 ft.

CARYOPHYLLEÆ.

*Stellaria.**

S. pungens (Bron.). T., N.S.W., S.A.

Ascends to 5400 ft.

S. flaccida (H.). T., N.S.W.

Ascends to 6000 ft.

S. multiflora (H.). T., N.S.W., S.A., W.A. N.Z.

Ascends to 4000 ft.

S. glauca (With.).

Common up to 2000 ft.

*Sagina.**

S. procumbens* (Linn.). N.S.W.

Ascends to 5000 ft.

*Colobanthus.*

C. benthamianus (Fen.). N.S.W.

(C. subulatus).

Restricted to the higher Alps, between 6000 and 7000 ft.; Mt. Bogong, 6500 ft.

*Scleranthus.**

S. pungens (Br.). N.S.W., S.A.

Ascends to 2000 ft.

S. biflorus (H.). T., N.S.W., Q.

Between 2000 and 6000 ft.

S. mniaroides (F. v. M.). N.S.W.

On higher Alps between 5000 and 7000 ft.

*Spergularia.*

S. rubra (Camb.). T., N.S.W., S.A., W.A.

Ubiquitous; ascends to 3000 ft.

*Polycarpon.*

P. tetraphyllum (Lœf.). S.A., W.A.

Ubiquitous; ascends to 2500 ft.

SALSOLACEÆ.

*Chenopodium.**

C. ambiguum (glaucum).

Ascends to 3000 ft.

POLYGONACEÆ.

*Polygonum.**

P. prostratum (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

P. minus (Hud.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.

*Rumex.**

R. Acetosella.*
Ubiquitous up to 3000 ft.

*Muehlenbeckia.*

M. adpressa (Meis.). T., N.S.W., S.A., W.A.
Ascends to 2000 ft. in northern gullies.

M. axillaris (H.). T., N.S.W.
Ascends to 3000 ft.

M. polygonoides (F. v. M.). N.S.W., S.A.
Ascends to 4000 ft.

CHORIPETALÆ PERIGYNÆ.

LEGUMINOSÆ.

*Oxylobium.*

O. ellipticum (Br.). T., N.S.W., Q.
Ascends to 6500 ft.

O. alpestre (F. v. M.). N.S.W.
On higher Alps between 5000 and 7000 ft.; Mt. Bogong, 6500 ft.

O. procumbens (F. v. M.). N.S.W.
Ascends to 5000 ft.

*Mirbelia.*

M. oxylobioides (F. v. M.). N.S.W.
Pretty shrub, 2600 to 4500 ft. One *var.* has keel of flower purple, another on margin of watercourses has an orange-coloured keel.

*Gompholobium.*

G. Huegelii (Ben.). T., N.S.W.
*Var.* leptophyllum ascends to 4000 ft.

*Sphærolobium.*

S. vimineum (Sm.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Viminaria.*

V. denudata (Sm.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.

*Daviesia.*

D. latifolia (Br.). T., N.S.W.
Ascends to 5000 ft.; most luxurious as small tree at 4000 ft., very variable.

D. corymbosa (Sm.). N.S.W., S.A., Q.
Ascends to 3000 ft.; two well-marked varieties are common.

D. ulicina (Sm.). T., N.S.W. S.A., Q.
Ascends to 3000 ft.

D. buxifolia.
Between 2000 and 4000 ft.

*Aotus.*

A. villosa (Sm.). T., N.S.W., Q.
Ascends to 3000 ft.

*Pultenæa.*

P. daphnoides (Wend.). T., N.S.W., S.A.
Ascends to 2600 ft.

P. Benthamii (F. v. M.).
Ascends to 4000 ft.

*Pultenæa—continued—*

P. Gunnii (Ben.). T., N.S.W.
Ascends to 3000 ft.

P. tenella (Ben.).
Ascends to 5000 ft.

P. ternata (F. v. M.). N.S.W., Q.
Ascends to 4000 ft.

P. scabra. N.S.W.
Ascends to 2000 ft.

P. styphelioides (Cun.). N.S.W.
Ascends to 3900 ft.

P. subumbellata (H.). T., N.S.W.
Between 4000 and 6000 ft.

P. hibbertioides (H.).
Ascends to 4600 ft.

P. mollis (Lind.). S.A.
Ascends to 2000 ft.

P. puniperina (Lab.). T.
Ascends to 4000 ft.

P. foliolosa (Cun.). N.S.W.
Ascends to 2000 ft.

P. Muelleri (Ben.).
Endemic between 4000 and 6000 ft. all over the higher Alps.

P. fasciculata (Ben.). T., N.S.W.
Sub-alpine; between 4000 and 5000 ft.

*Dillwynia.*

D. ericifolia (Sm.). T., N.S.W., S.A., Q.
Very variable; ascends to 3000 ft.

D. juniperina (Sieb.). N.S.W., Q.
Ascends to 3000 ft.

D. cinerascens (Br.). T., N.S.W., S.A., W.A.
Ascends to 4000 ft.

*Platylobium.*

P. formosum (Sm.). T., N.S.W., Q.
Ascends to 2000 ft.

P. obtusangulum (H.). T., S.A.
Ascends to 4000 ft.

P. triangulare (Br.). T., S.A.
Ascends to 4000 ft.

*Bossæia.*

B. foliosa (Cunn.). N.S.W.
*Var.* ascends to 5000 ft.

B. prostrata (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

B. microphylla (Sm.). N.S.W.
Ascends to 2000 ft.

B. cinerea (Br.).
Ascends to 2000 ft.

B. bracteosa (F. v. M.).
Common on tablelands between 4000 and 6000 ft.

B. riparia (Cunn.). T., N.S.W., S.A.
Ascends to 3000 ft.

*Hovea.*

H. heterophylla (Cunn.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

H. longifolia (Br.). T., N.S.W., S.A., Q., N.A
Ascends to 6500 ft.; the alpine form is characterised by rusty-revolute tomentose leaves (Bogong).

*Goodia.*
G. lotifolia (Salis.). T., N.S.W., S.A., Q., W.A.
Ascends to 4000 ft.; very fine flowering shrub, and gregarious.

*Lotus.**
L. corniculatus * (Linn.). T., N.S.W., S.A.
(Europe). Ubiquitous; ascends to 4000 ft.
L. australis (And.). T., N.S.W., S.A., Q., W.A., N.A.
(Polynesia). Ascends to 5000 ft.

*Psoralea.*
P. adscendens (F. v. M.). T., N.S.W., S.A.
*Var.* parva ascends to 5000 ft.

*Indigofera.*
I. australis (Will.). T., N.S.W., S.A., Q., W.A.
Ascends to 4800 ft.; common in sub-alpine areas.

*Swainsonia.*
S. phacoides (Ben.). N.S.W., S.A., Q., W.A., N.A.
Ascends to 3600 ft.; very fine purple flowers.
S. lessertiifolia (DC.). T., N.S.W., S.A.
Ascends to 2000 ft.

*Desmodium.*
D. varians (End.). T., N.S.W., Q.
Ascends to 3600 ft.

*Glycine.*
G. clandestina (Wen.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.
G. Latrobeana (Ben.). T., S.A.
Ascends to 3200 ft.

*Kennedya.*
K. rubicunda (Ven.). T., N.S.W., Q.
Ascends to 2600 ft. on southern ridges.
K. prostrata (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.
K. monophylla (Ven.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

*Cassia.*
C. australis (Sims). N.S.W., Q., N.A.
Ascends to 2000 ft.

*Acacia (Pungentes).*
A. siculiformis (Cunn.). T., N.S.W.
Ascends to 6000 ft.
A. juniperina (Will.). T., N.S.W., Q.
Ascends to 3000 ft.

—— *(Uninerves).*
A. armata (Br.). N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
A. vomeriformis (Cunn.). T., N.S.W., S.A.
Ascends to 4000 ft.
A. stricta (Will.). T., N.S.W.
Ascends to 2000 ft.
A. penninervis (Sieb.). T., N.S.W., Q.
Ascends to 4000 ft.
A. pycantha (Ben.). N.S.W., S.A.
Ascends to 4000 ft.
A. amœna (Wen.). N.S.W.
Ascends from 2000 to 4000 ft.
A. lunata (Sieb.). N.S.W., Q.
Ascends to 3000 ft.

*Acacia* (*Uninerves*)—*continued*—
A. pravissima (F. v. M.). N.S.W.
Ascends from 2000 to 5000 ft.
A. myrtifolia (Will.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.
—— (*Plurinerves*).
A. subporosa (F. v. M.). N.S.W.
Ascends to 2000 ft.
A. melanoxylon (Br.). T., N.S.W., S.A.
Ascends to 4500 ft.; a fine timber; ornamentai tree.
A. oxycedrus (Sieb.). T., N.S.W., S.A.
Ascends to 2000 ft.
A. verticillata (Will.). T. N.S.W., S.A.
Ascends to 3000 ft.
—— (*Juliferæ*).
A. dallachiana (F. v. M.).
*Var.* between 4000 and 5000 ft.
A. alpina (F. v. M.). N.S.W.
*Var.* on higher Alps, between 5500 and 7000 ft.; widely distributed, Mt. Bogong.
A. longifolia (Will.). T., N.S.W. S.A., Q.
*Var.* phlebophylla, between 3000 and 4000 ft.
—— (*Bipinnatæ*).
A. Mitchelli (Ben.). S.A.
Ascends to 2000 ft.; rare in these regions.
A. discolor (Will.). T., N.S.W.
Ascends to 4000 ft.
A. decurrens (Will.). T., N.S.W., S.A., Q.
Ascends to 4500 ft. Common wattle.
A. dealbata (Link.). T., N.S.W., S.A.
Ascends to 4000 ft. Common wattle.

ROSACEÆ.

*Geum.**
G. urbanum* (Linn.). T., N.S.W., S.A., N.Z., Europe.
Ascends to 3000 ft.
*Rubus.**
R. gunnianus (H.). T.
Ascends to 4000 ft.
R. parvifolius (Linn.). T., N.S.W., S.A., Q.
Ascends to 4500 ft.
*Alchemilla* *
A. vulgaris* (Linn.). N.S.W.
Ascends to 3000 ft.
*Acæna.*
A. ovina (Cun.). T., N.S.W., S.A., Q., W.A.
Ascends to 6000 ft. Antarctic species.
A. Sanguisorbae (Vahl.). T., N.SW., S.A., Q., N.Z., S.Af.
Ascends to 5000 ft. Antarctic species.

SAXIFRAGEÆ.

*Bauera.*
B. rubioides (And.). T., N.S.W., S.A.
Ascends to 4000 ft.
B. sessiliflora (F. v. M.).
Ascends to 3000 ft.

### CRASSULACEÆ.

*Tillæa.*

T. verticillaris (Can.). T., N.S.W., S.A., Q., W.A.
Common up to 3000 ft.

T. purpurata (H.). T., N.S.W., S.A., W.A.
Ascends to 2500 ft.

T. macrantha (H.). T., N.S.W., S.A.
Ascends to 3000 ft.

### ONAGREÆ.

*Epilobium.**

E. tetragonum (Linn.). T., N.S.W., S.A., Q., W.A., N.Z., Europe.
Ascends to 4000 ft.

E. glabellum (Forst.).
Ascends to 3000 ft.

### SALICARIÆ.

*Lythrum.**

L. Salicaria * (Linn.). T., N.S.W., S.A., Q., Europe.
Common up to 4000 ft. in swampy areas.

### HALORAGEÆ.

*Haloragis.*

H. micrantha (Br.). T., N.S.W., S.A., Q., N.Z., Japan, Ind.
Ascends to 3000 ft.

H. tetragyna (Br.). T., N.S.W., S.A., Q., N.Z.,
Ascends to 4000 ft.

H. teucrioides (Gray). T., N.S.W., S.A., Q., W.A.
Ascends to 2600 ft.

*Myriophyllum.**

M. pedunculatum (H.). T., S.A., W.A.
In streams, up to 4000 ft.

M. elatinoides (Gaud.). T., N.S.W., S.A., N.Z., Europe.

### MYRTACEÆ.

*Calycothrix.*

C. tetragona (Lab.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft., western slopes.

C. Sullivani (F. v. M.).
Ascends to 3000 ft.; rare.

*Lhotzkya.*

L. genetylloides (F. v. M.). S.A.
Ascends to 2000 ft., western slopes.

*Thryptomene.*

T. mitchelliana (F. v. M.). S.A.
Ascends to 2000 ft., western slopes.

*Bæckea.*

B. diffusa (Sieb.). T., N.S.W., S.A.
Ascends to 3700 ft.

B. gunniana (Schaur.). T., N.S.W.
Common between 5000 and 6000 ft.; Mt. Bogong, 6000 ft.

B. crenatifolia (F. v. M.).
Ascends to 3000 ft.

*Leptospermum.*
L. scoparium (R. and G. Foster). T., N.S.W., S.A., Q.
Ascends to 3000 ft.
L. lanigerum (Sm.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.
L. attenuatum (Sm.). N.S.W., Q.
Ascends 2000 to 3000 ft.
L. juniperinum.
Ascends to 4000 ft.

*Kunzea.*
K. Muelleri (Ben.). N.S.W.
Endemic between 5000 and 7000 ft.; Mt. Bogong, 6500 ft.
K. parvifolia (Schau.). N.S.W.
Ascends to 2000 ft.
K. corifolia (Reich.). T., N.S.W.
Ascends to 3000 ft.
K. peduncularis (F. v. M.). N.S.W.
Between 4000 and 500 ft.

*Callistemon.*
C. salignus (Can.). N.S.W., Q.
*Var.* siebieriana, between 4000 and 5000 ft.; Mt. Bogong, 6000 ft.
C. lanceolatus. N.S.W., Q.
Ascends to 2000 ft.

*Melaleuca.*
M. squarrosa (Donn.). T., N.S.W., S.A.
Ascends to 3000 ft.
M. gibbosa (Lab.). T., S.A.
Ascends to 2000 ft.
M. ericifolia (Sm.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Eucalyptus* (*Renanthera*).
E. stellulata (Sieb.). N.S.W.
Ascends to 5000 ft.
E. pauciflora (Sieb.). T., N.S.W., S.A.
Ascends to 6800 ft.; a dwarfed, stunted shrub; forms forests at 4500 to 5500 ft.
E. regnans (F. v. M.). T., N.S.W.
(White gum or blackbutt.)
Ascends to 3000 ft.; tallest form, size 400 ft.
E. amygdalina (Lab.). T., N.S.W.
(White gum.)
Ascends to 4500 ft., varied species. Three well-marked varieties, narrow-leaved ones to 4500 ft. in shaded localities; broad-leaved ones on sunny, dry slopes, up to 4000 ft. on N. side of spurs.
E. obliqua (Lher.) (Messmate). T., N.S.W., S.A.
Ascends to 4000 ft.; forms forests with E. siebieriana, E. viminalis, and E. amygdalina.
E. stricta (Sieb.). N.S.W.
At 4000 ft., Buchan and Snowy Rivers.
E. macrorhyncha (F. v. M.). N.S.W.
Ascends to 3000 ft., Dividing range (Wentworth).
E. capitellata (Sm.). N.S.W., S.A.
(Stringy bark.)
Ascends to 3000 ft. in Tambo Valley.

*Eucalyptus* (*Renantheræ*)—*continued*—

E. eugenioides (Sieb.). N.S.W.

Ascends to 3000. ft.; forms forests in Wentworth and Tambo Valleys.

E. piperita (Sm.). N.S.W.

Ascends to 3000 ft.; this species is allied to E. eugenioides.

E. pilularis (Sm.). N.S.W.

(Blackbutt.)

Ascends to 3500 ft.

E. siebieriana (F. v. M.). T., N.S.W., S.A.

(White gum-topped stringy bark.)

Forms zones of growth, common between 3500 and 4500 ft.; two well-marked varieties occur—white ironbark, in Mitchell River Valley to 4500 ft., and woollybutt, in Tambo Valley at 4000 ft.

*Eucalptus* (*Parallelantheræ*).

E. Globulus (Lab.). T., N.S.W.

(Blue gum.)

Ascends to 4000 ft. in isolated colonies; Tambo Valley, 2000 ft.; Mitta Mitta Valley, Gelantipy, 3000 ft.

E. Gunnii (H.). T., N.S.W., S.A.

Ascends to 3000 ft., Mt. Livingstone, forms two varieties; and to 5000 ft. on high tablelands, dwarfed form.

E. pulverulenta (Sims.). N.S.W.

Ascends to 3000 ft., Omeo Plains.

E. stuartiana (F. v. M.). T., N.S.W., S.A.

Ascends to 2500 ft., Dargo and Omeo Road.

E. viminalis (Lab.). T., N.S.W., S.A.

Ascends to 4000 ft., Livingstone Ck., two varieties; Dargo High Plains, 4500 ft.

### RHAMNACEÆ.

*Pomaderris.*

P. elliptica (Lab.). T., N.S.W., N.Z.

2000 to 3000 ft.

P. vacciniifolia (Reis. and F. v. M.). N.S.W.

At 3100 ft.

P. apetala (Lab.). T., N.S.W., S.A.

Ascends to 4000 ft.

P. betulina (Cun.). N.S.W.

At 3000 ft.

P. racemosa (H.). T., N.S.W., S.A.

Ascends to 2000 ft.

P. elachophylla (F. v. M.).

At 2000 to 3000 ft.

P. phylicifolia (Lod.). T.

Ascends to 3500 ft.

*Cryptandra.*

C. amara (Sm.). T., N.S.W., S.A., Q.

At 3000 to 4000 ft.

*Colletia.*

C. pubescens (Brog.). T., N.S.W.

Ascends to 3000 ft.

### ARALIACEÆ.

*Astrotricha.*

A. ledifolia (Can.). N.S.W.

Ascends to 2000 ft.

*Panax.*
P. sambucifolius (Sieb.). T., N.S.W., Q.
Ascends to 4000 ft.

### UMBELLIFERÆ.

*Hydrocotyle.**
H. laxiflora (Can.). N.S.W., S.A., Q.
At 2000 to 3000 ft.

*Didiscus.*
D. humilis (H.). T., N.S.W.
Sub-alpine, at 4500 ft.

*Trachymene.*
T. Billardieri (F. v. M.). N.S.W.
At 3000 to 3800 ft.

*Azorella.*
A. Muelleri (Ben.).
At 3000 to 4000 ft.
A. cuneifolia (F. v. M.).
At 4000 to 6500 ft.; Mt. Bogong, 4800 to 6500 ft.
A. dichopetala (Ben.). T.
Ascends to 5800 ft., Mt. Bogong.

*Huanaca.*
H. hydrocotylea (Ben.). T.
At 4000 to 6500 ft., Mt. Bogong.

*Apium.**
A. prostratum (Lab.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
A. leptophyllum (F. v. M.). N.S.W., Q.
Ascends to 3000 ft.

*Seseli.*
S. harveyanus (F. v. M.).
At 5000 to 6000 ft.

*Aciphylla.*
A. simplicifolia (F. v. M.). N.S.W.
Ascends to 4000 ft.
A. glacialis (F. v. M.). N.S.W.
At 5000 to 6500 ft., Mt. Bogong.

*Oreomyrrhis.*
O. andicola (End.). T., N.S.W., S.A., Q.
At 5000 to 6000 ft.
O. pulvinifica (F. v. M.). N.S.W.
Higher Alps, 6500 to 7200 ft.; Mt. Bogong, 5800 to 6508 ft.

## SYNPETALÆ PERIGYNÆ.

### SANTALACEÆ.

*Thesium.*
T. australe (Br.). T., N.S.W., Q.
At 2600 to 3000 ft.

*Choretrum.*
C. lateriflorum (Br.). N.S.W.
At 3000 to 4000 ft.

*Leptomeria.*
L. aphylla (Br.). N.S.W., S.A.
Ascends to 3000 ft.

*Omphacomeria.*
O. acerba (Can.). N.S.W.
At 3000 to 4000 ft.

*Exocarpos.*

E. cupressiformis (Lab.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

E. spartea (Br.). N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

E. stricta (Br.). T., N.S.W., S.A.
Ascends to 3800 ft.

E. humifusa (Br.). T., N.Z., Sandwich Islands.
Ascends to 6000 ft.

E. nana (H.). T.
At 4000 to 6000 ft.

PROTEACEÆ.

*Conospermum.*

C. patens (Schl.). N.S.W., S.A.
Ascends to 2000 ft.

*Persoonia.*

P. confertiflora (Ben.).
Ascends to 5000 ft.; at 2000 ft. an erect shrub, at the higher levels dwarfed and divaricate.

P. linearis (And.). N.S.W., Q.
Ascends to 3000 ft.

P. rigida (Br.). N.S.W.
Ascends to 3500 ft.

P. myrtilloides (Sieb.). N.S.W.
Ascends to 3000 ft.

P. chamæpeuce (Lhot.). N.S.W.
Ascends to 4000 ft. as a decumbent shrub.

P. juniperina (Lab.). T., N.S.W., S.A.
Ascends to 5000 ft. all over the Alps as a divaricate shrub.

*ri'*

O. lancifolia (F. v. M.).
Endemic, 5900-7000 ft., in the higher altitudes; Mt. Bogong, 6500 ft.

*Grevillea.*

G. ilicifolia (Br.). S.A.
Ascends to 2000 ft.

G. alpina (Lind.).
At 2500 to 6000 ft., Mt. Bogong.

G. rosmarinifolia (Cun.). N.S.W.
Ascends to 4000 ft.

G. miqueliana (F. v. M.).
At 4000 to 5000 ft., fine shrub.

G. Victoriæ (F. v. M.). N.S.W.
Ascends to 3000 ft.

G. juniperina (Br.). N.S.W.
Ascends to 4000 ft.

G. confertifolia (F. v. M.).
At 3000 to 4000 ft.

G. parviflora (Br.). N.S.W., S.A.
Ascends to 4000 ft. as a dwarfed *var.*

G. australis (Br.). T., N.S.W.
Ascends to 4000-5000 ft.; a much branched shrub.

G. ramosissima (Meis.). N.S.W.
Ascends to 3000 ft.; is rapidly becoming extinct at the higher levels.

*Hakea.*

H. eriantha (Br.). N.S.W.

At 3000–4000 ft.; an erect arborescent shrub.

H. lasiantha (Br.).

H. rugosa (Br.). S.A.

Ascends to 3000 ft.; a very prostrate species.

H. nodosa (Br.). T.

Ascends to 2000 ft.

H. acicularis (Br.). T., N.S.W.

At 4800 to 5000 ft.; a small tree, 15 ft. high.

H. microcarpa (Br.). T., N.S.W.

Ascends to 5000 ft.; a stout rigid shrub, about 12 ft. high, at the lower levels, but becomes almost prostrate at the higher altitudes.

*Lomatia.*

L. ilicifolia (Br.). N.S.W.

At 2000 to 5000 ft.; arboreous shrub, 20 ft. high at sub-alpine habitats.

L. longifolia (Br.). N.S.W.

Ascends to 4000 ft.; attains a height of 12 ft. at sub-alpine habitats.

*Telopea.*

T. oreades (F. v. M.).

Ascends in Snowy River Valley to 3000 ft.; attains a height of 50 ft. at the sub-alpine habitats.

*Banksia.*

B. collina (Br.). N.S.W., Q.

Ascends to 2000 ft.

B. marginata (Cav.). T., N.S.W., S.A.

Ascends to 3000 ft.; small bushy tree, Omeo district.

B. integrifolia (Linn.). N.S.W., Q.

Ascends to 4500 ft.; a low diffuse shrub.

B. serrata (Linn.). T., N.SW.

Ascends to 2000 ft.; on the southern sub-alpine sandy areas.

THYMELEÆ.

*Pimelea.*

P. alpina (F. v. M.). N.S.W.

At 5000 to 7000 ft.; Mt Bogong, 6500 ft.

P. glauca (Br.). T., N.S.W., S.A., Q.

At 2000 to 3000 ft.

P. ligustrina (Lab.). T., N.S.W., S.A.

At 3800 to 6000 ft.; 5800 ft., Mt. Bogong.

P. axiflora (F. v. M.). T., N.S.W.

Ascends to 3000 ft.

P. pauciflora (Br.). T., N.S.W., Q.

At 2000 to 4000 ft.

P. serpyllifolia (Br.). T., N.S.W., S.A., W.A.

Ascends to 2000 ft.

P. flava (Br.). T., N.S.W., S.A., Q., W.A.

Ascends to 3000 ft.

P. curviflora (Br.). T., N.S.W., S.A., Q.

Ascends to 3500 ft.

P. dichotoma.

Ascends to 2000 ft.

RUBIACEÆ.

*Coprosma.*
C. pumila (H.). T., N.Z.
At 4000 to 5000 ft.
C. Billardieri (H.). T., N.S.W.
(C. microphylla.)
Ascends to 4000 ft.
C. hirtella (Lab.). T., N.S.W., S.A.
Ascends to 5000 ft.

*Opercularia.*
O. aspera (Gær.). N.S.W., Q.
Ascends to 2000 ft.

*Asperula.**
A. oligantha (F. v. M.). T., N.S.W., S.A., Q.
Ascends to 6000 ft., Mt. Bogong.

*Galium.**
G. australe (Can.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

CAPRIFOLIACEÆ.

*Sambucus.**
S. gaudichaudiana (Can.). T., N.S.W., S.A., Q.
At 3000 to 5000 ft.

COMPOSITÆ.

*Lagenophora.*
L. Billardieri (Cass.). T., N.S.W., S.A., Q., W.A. Ind., Japan.
Ascends to 3500 ft.
L. emphysopus (H.). T., N.S.W.
Ascends to 3000 ft.

*Brachycome.*
B. diversifolia (Fos. and Mey.). T., N.S.W., S.A.
Ascends to 4000 ft.
B. radicans (Steetz.). T., N.S.W.
B. scapigera (Can.). N.S.W.
Ascends to 4000 ft.
B. angustifolia (Cun.). T., N.S.W.
At 2000 to 3000 ft.
B. exilis (Sond.). N.S.W., S.A.
Ascends to 5000 ft., Mt. Bogong.
B. ptychocarpa (F. v. M.). N.S.W.
Ascends to 3000 ft.
B. dicipiens (H.). T., N.S.W., S.A.
Ascends to 5000 ft.
B. nivalis (F. v. M.). N.S.W.
At 5000 to 7000 ft.; Mt. Bogong, 6000 ft.
B. stricta (Can.). T., N.S.W.
Ascends to 3000 ft.
B. ciliaris (Less.). T., N.S.W., S.A., Q., W.A.
At 3000 ft.

*Calotis.*
C. glandulosa (F. v. M.). N.S.W.
Ascends to 2000 ft.
C. scabiosifolia (Sond. and F. v. M.). N.S.W., S.A.
Ascends to 3000 ft.

*Calotis—continued—*

C. scapigera (H.). N.S.W., S.A., Q., N.A.
Ascends to 2000 ft.

C. lappulacea (Ben.). N.S.W., S.A., Q., W.A.
At 2500 ft.

*Aster.**

A. megalophyllus (F. v. M.). N.S.W.
Ascends to 5000 ft.

A. alpicola (F. v. M.). N.S.W.
At 4000 to 6000 ft.

A. rosmarinifolius (Cun.). N.S.W.
Ascends to 6000 ft., Mt. Bogong.

A. argophyllus (Lab.). T., N.S.W.
(Native musk.)
Ascends to 5000 ft.; dwarfed and stunted at this elevation.

A. myrsinoides (Lab.). T., N.S.W., S.A.
At 2000 to 5000 ft.

A. stellulatus (Lab.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.

A. florulentus (F. v. M.). T., N.S.W.
Ascends to 4000 ft.

A. microphyllus (Pers.). T., N.S.W., S.A.
Ascends to 3000 ft.

A. iodochrous (F. v. M.). N.S.W.
Ascends to 2000 ft.

A. glandulosus (Lab.). T., N.S.W., S.A.
Ascends to 5800 ft., Mt. Bogong.

A. adenophorus (F. v. M.). N.S.W.
Ascends to 4000 ft.

A. Muelleri (Sond.).
At 6000 to 7000 ft., Kosciusko Plateau.

A. Huegelii (F. v. M.). T., N.S.W., S.A., W.A.
Ascends to 2000 ft.

A. Celmisia (F. v. M.). T., N.S.W.
At 4000 to 7000 ft.; Mt. Bogong, 6500 ft.

*Vittadinia.*

V. australis (Rich.). T., N.S.W., S.A., Q.
Ascends to 2500 ft.; at Omeo, 1 ft. 18 in.

*Erigeron.*

E. pappochromus (Lab.). T., N.S.W.
Alpine at 6000 to 7000 ft.; Mt. Bogong, 6500 ft.

*Gnaphalium.**

G. japonicum (Thum.). T., N.S.W., S.A., Q., W.A.
At 4000 to 6000 ft.

G. alpigenum (F. v. M.). T.
Alpine at 4500 to 6500 ft.; 6500 ft., Mt. Bogong.

G. Traversii (H.). N.S.W.
Ascends to 3500 ft.

*Antennaria.**

A. uniceps (F. v. M.). N.S.W.
Ascends to 5000 ft.

*Leontopodium.*

L. latipes (F. v. M.). T., N.S.W.
At 6000 to 7000 ft.; Mt. Bogong, 6500 ft. (native edelweiss).

*Podolepis.*

P. longipedata (Cun.. N.S.W., Q.
Ascends to 4000 ft.

P. acuminata (Br.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.

*Leptorhynchos.*
L. squamatus (Less.). T., N.S.W., S.A.
Ascends to 5000 ft.
L. tenuifolius (F. v. M.). S.A.
Ascends to 2000 ft.
L. elongatus (Can.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

*Helipterum.*
H. anthemoides (Can.). T., N.S.W., S.A., Q.
At 3000 to 6500 ft., Mt. Bogong.
H. incanum (Can.). T., N.S.W., S.A., Q.
*Var.* auriceps, 2000 to 4000 ft.; an alpine form common between 5000 and 6000 ft., Mt. Bogong.
H. dimorpholepis (Ben.). N.S.W., S.A., W.A.
Ascends to 3000 ft.

*Helichrysum.*
H. scorpioides (Lab.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.
H. obtusifolium (Sond. and F. v. M.). N.S.W., S.A. W.A.
Ascends to 4000 ft.
H. lucidum (Henckel.). T., N.S.W., S.A., Q., W.A., N.A.
(syn. H. bractiatum.)
Narrow leaved *var.*, 2000 to 3000 ft.; Alpine *var.*, 5000 to 6000 ft., Mt. Bogong.
H. leucopsidium (Can.). T., N.S.W., S.A.
Ascends to 4000 ft.
H. apiculatum (Can.). T., N.S.W., S.A., Q., W.A., N.A.
1 ft. 15 in.; ascends to 3000 ft.
H. semipapposum (Can.). T., N.S.W., S.A., Q., W.A.
Ascends to 5000 ft.
H. rosmarinifolium (Less.). T., N.S.W.
*Var.* thyrsoides, 2000 to 5000 ft., Mt. Bogong.
H. ferrugineum (Less.). T., N.S.W., S.A.
Ascends to 2000 ft.
H. baccharoides (F. v. M.). T.
Common between 5000 and 6500 ft.; Mt. Bogong, 6500 ft.
H. pholidotum (F. v. M.). N.S.W., S.A.
Ascends to 3000 ft.
H. Stirlingii (F. v. M.).
At 4600 ft., Mt. Hotham.

*Cassinia.*
C. aculeata (Br.). T., N.S.W., S.A.
Ascends to 2000 ft.

*Humea.*
H. elegans (Sm.). N.S.W.
Ascends to 2000 ft.

*Ixodia.*
I. achilleoides (Br.). S.A.
Ascends to 3000 ft.

*Craspedia.*
C. Richea (Cass.). T., N.S.W., S.A., Q., W.A., N.A. N.Z.
Very variable; lowland form, 4000 ft.; *var.* alpina, 5000 to 6000 ft., Mt. Bogong.

*Cotula.*
C. australis (H.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
C. alpina (H.). T., N.S.W.
Sub-alpine; at 3000 to 6500 ft., Mt. Bogong.

*Cotula—continued—*

C. filicula (H.). T., N.S.W.

Ascends to 2000 ft.

*Centipeda.*

C. orbicularis (Lour.). T., N.S.W., S.A., Q., W.A., N.A.

At 2500 to 3000 ft.

*Abrotanella.*

A. nivigena (F. v. M.).

At 4000 to 7000 ft.; 6000 ft., Mt. Bogong.

*Senecio.**

S. pectinatus (Can.). T., N.S.W.

Sub-alpine; at 6000 ft., Mt. Bogong.

S. lautus (Sol.). T., N.S.W., S.A., Q., W.A., N.A., N.Z.

Ascends to 3600 ft.

S. vagus (F. v. M.). N.S.W.

Ascends to 3000 ft.

S. australis (Rich.). N.S.W., S.A.

At 3000 to 6000 ft., Mt. Bogong.

S. georgianus (Can.). T., N.S.W., S.A., W.A.

Ascends to 4000 ft.

S. Bedfordii (F. v. M.). T., N.S.W.

Ascends to 4800 ft.; this forms a fine tree at the lower levels.

*Erechtites.*

E. hispidula (Can.). T., N.S.W., S.A., W.A.

Ascends to 3000 ft.

*Cymbonotus.*

C. lawsonianus (Gaud.). T., N.S.W., S.A., Q., W.A.

Ascends to 6000 ft.

*Centaurea.*

C. australis (Ben.). N.S.W. Q.

Ascends to 3500 ft.

*Microseris.*

M. Forsteri (H.). T., N.S.W., S.A., W.A., N.Z.

Ascends to 5000 ft., Mt. Bogong.

### CAMPANULACEÆ.

*Lobelia.**

L. gelida (F. v. M.). N.S.W.

Ascends to 6000 ft.

L. concolor (Br.). N.S.W., S.A., Q.

Ascends to 3000 ft.

L. simplicicaulis (Br.). T., N.S.W., S.A.

Ascends to 2000 ft.

L. anceps (Thun.). N.Z., S. Af., America.

Ascends to 2000 ft.

*Isotoma.*

I. axillaris (Lind.). N.S.W., Q.

Ascends to 2800 ft.

I. fluviatilis (F. v. M.). T., N.S.W., S.A., Q.

Ascends to 3000 ft.

*Wahlenbergia.**

W. gracilis (Can.). T., N.S.W., S.A., Q., W.A., N.A., N.Z., Ind., S. Af.

Ascends to 5000 ft.; very variable; Mt. Bogong (deep blue petals).

CANDOLLEACEÆ.

*Candollea* (*Stylidium*).

C. graminifolia (Swar.). T., N.S.W., S.A., Q.
Ascends to 6000 ft.; maximum luxuriance at 4000 ft.; Mt. Bogong, 6000 ft.

C. sobolifera (F. v. M.).
Ascends to 3000 ft.

C. calcarata (Br.). S.A., W.A.
Ascends to 2000 ft.

C. serrulata.
Mt. Bogong, 6000 ft.

*Levenhookia.*

L. dubia (Sond). T., N.S.W., S.A., W.A.
Ascends to 3000 ft.

GOODENIACEÆ.

*Dampiera.*

D. stricta (Br.). T., N.S.W., S.A.
Ascends to 2000 ft.

*Scævola.*

S. hispida (Cav.). N.S.W., Q.
Ascends to 2000 ft.

S. æmula (Br.). T., N.S.W., S.A., W.A.
Ascends to 2000 ft.

S. microcarpa (Cav.). T., N.S.W., S.A., Q.
Ascends to 2500 ft.

*Selliera.*

S. radicans (Cav.). T., N.S.W., S.A. N.Z.
Antarctica; ascends to 3000 ft.

*Goodenia.*

G. ovata (Sm.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

G. hederacea (Sm.). N.S.W., Q.
Ascends to 3500 ft. *Var.* cordifolia.

G. Macmillani (F. v. M.).
Ascends to 3000 ft.

G. elongata (Lab.). T., N.S.W., S.A.
Ascends to 2000 ft.

*Velleya.*

V. paradoxa (Br.). T., N.S.W., S.A., Q.
Ascends to 6000 ft.

V. montana (H.). T., N.S.W.
Sub-alpine, at 4500 to 6000 ft.

SYNPETALÆ HYPOGYNÆ.

GENTIANEÆ.

*Limnanthemum.*

L. crenatum (F. v. M.). N.S.W., S.A. Q., N.A.
At 3000 to 3500 ft.

L. geminatum (Gris.). N.S.W., Q., N.A.
At 3000 to 4000 ft.

*Sebæa.*

S. ovata (Br.). T., N.S.W., S.A., Q., W.A., N.Z.
Ascends to 3000 ft.

S. albidiflora (F. v. M.). T., S.A.
Ascends to 2000 ft.

*Erythræa.**
E. australis (Br.). T., N.S.W., S.A., Q., W.A., N.A.
From 2000 to 6000 ft.
*Gentiana.**
G. saxosa (Fors.). T., N.S.W., S.A.
Alpine form, 400 to 6200 ft., Mt. Bogong.

LOGANIACEÆ.

*Mitrasacme.*
M. serpyllifolia (Br.). T., N.S.W.
Ascends to 2000 ft.
*Logania.*
L. floribunda (Br.). N.S.W.
Ascends to 2500 ft.

PLANTAGINEÆ.

*Plantago.**
P. varia (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.
P. stellaris (F. v. M.). N.S.W.
Alpine, 6000 to 7000 ft.; 6300 ft., Mt. Bogong.
P. Gunnii (H.). T., N.S.W.
Alpine, ascends to 4000 ft.

PRIMULACEÆ.

*Samolus.*
S. repens (Pers.). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 3000 ft.

JASMINEÆ (OLEACEÆ).

*Notelæa.*
N. ligustrina (Vent.). T., N.S.W.
Ascends to 3000 ft.

APOCYNEÆ.

*Alyxia.*
A. buxifolia (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
*Lyonsia.*
L. straminea (Br.). T., N.S.W.
Ascends to 2500 ft.

ASCLEPIADEÆ.

*Tylophora.*
T. barbata (Br.). N.S.W.
Ascends to 2500 ft.
*Marsdenia.*
M. rostrata (Br.). N.S.W., Q.
Ascends to 2000 ft.

CONVOLVULACEÆ.

*Convolvulus.*
C. erubescens (Sims.). T., N.S.W., S.A., Q., W.A., N.Z., Europe.
Ascends to 3000 ft.
C. sepium (Linn.). T., N.S.W., S.A., W.A.
Ascends to 3000 feet.
*Dichondra.*
D. repens (R. and G. Fors.). T., N.S.W., S.A., Q., W.A., N.A., N.Z., Ind., S. Af., S. Amer.
Ascends to 2500 ft.

*Wilsonia.*
W. rotundifolia (H.). N.S.W., S.A., W.A.
Ascends to 2000 ft.

SOLANACEÆ.

*Sòlanum**
S. nigrum * (Linn.). T., N.S.W., S.A., Q., W.A., N.A.
Ubiquitous ; ascends to 2500 ft.
S. vescum (F. v. M.). T., N.S.W.
Ascends to 4000 ft.
S. aviculare (Fors.). T., N.S.W., S.A., Q., N.Z.
Ascends to 2500 ft.

*Lycium.*
L. australe (F. v. M.). N.S.W., S.A., W.A.
Ascends to 3000 ft.

*hocercis.*
A. Eadesii (F. v. M.). N.S.W., S.A.
Ascends to 3600 ft.

SCROPHULARINEÆ.

*Mimulus.**
M. repens (Br.). T., N.S.W., S.A., Q., W.A., N.Z.
Ascends to 2000 ft.

*Gratiola.*
G. peruviana (Linn.). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 4000 ft.
G. nana (Ben.). T., N.S.W.
Ascends to 3000 ft.

*Limosella.*
L. aquatica (Linn.). T., N.S.W.. S.A., W.A., N.Z.
(L. antarctica). Ascends to 2100 ft.

*Veronica.**
V. densifolia (F. v. M.). N.S.W.
Ascends to 2000 ft.
V. perfoliata (Br.). N.S.W.
Common at 4000 to 5000 ft.
V. Derwentia (Lit.). T., N.S.W., S.A., Q.
Ascends to 5800 ft., Mt. Bogong.
V. nivea (Lind.). T., N.S.W.
Sub-alpine ; at 5000 ft.
V. serpyllifolia (Linn.). N.S.W.
At 5000 to 6000 ft.

*Euphrasia.**
E. Brownii (F. v. M.). T., N.S.W., S.A., Q., W.A.
At 4000 ft.; at 6500 ft., Mt. Bogong.
E. scabra (Br.). T., N.S.W., S.A., Q., W.A.
At 3000 to 4000 ft.
E. antarctica (Ben.). N.S.W.
At 5000 to 6500 ft.

LENTIBULARIEÆ.

*Utricularia.**
U. flexuosa (Vahl.). T., N.S.W., S.A., Q., W.A., N.A.
At 2500 ft.
U. dichotoma (Lab.). T., N.S.W., S.A., Q.
At 5000 to 6000 ft.

GESNERIACEÆ.

*Fieldia.*

F. australis (Cun.). N.S.W.
Ascends to 3000 ft.; on fern trees.

BIGNONIACEÆ.

*Tecoma.*

T. australis (Br.). N.S.W., S.A., Q., N.A.
Ascends, on southern slopes, to 3500 ft.

ASPERIFOLIÆ.

*Myosotis.**

M. australis (Br.). T., N.S.W., S.A., W.A.
Ascends to 5000 ft.

M. suaveolens (Poir.). T., N.S.W.
Ascends to 5000 ft.

*Cynoglossum.*

C. suaveolens (Br.). T., N.S.W., S.A.
Ascends to 5000 ft.

LABIATÆ.

*Plectranthus.*

P. parviflorus (Will.). N.S.W., S.A., Q., N.A.
Ascends to 2000 ft.

*Mentha.**

M. laxiflora (Ben.). N.S.W.
Ascends to 3000 feet.

M. australis (Br.). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 3000 ft.

M. gracilis (Br.). T., N.S.W., S.A.
Ascends to 3000 ft.

M. satureioides (Br.). T., N.S.W., S.A., Q., W.A
Ascends to 2000 ft.

*Lycopus.**

L. australis (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Salvia.*

S. plebeja (Br.). N.S.W., Q.
Ascends to 2000 ft.

*Scutellaria.**

S. mollis (Br.). N.S.W.
Ascends to 3000 ft.

S. humilis (Br.). T., N.S.W., S.A., Q.
At 3000 to 4000 ft.

*Prostanthera.*

P. lasianthos (Lab.). T., N.S.W., S.A., Q.
Ascends to 3800 ft.

P. rotundifolia (Br.). T., N.S.W., S.A.
At 2000 to 3000 ft.

P. hirtula (F. v. M.). N.S.W.
Ascends to 2000 ft.

P. denticulata (Br.). N.S.W.
Ascends to 3000 ft.

P. cuneata (Ben.). T., N.S.W.
Common at higher elevations up to 6000 ft., Mt. Bogong.

P. phylicifolia (F. v. M.). N.S.W., Q.
Ascends to 3600 ft.

P. decussata (F. v. M.).
Ascends to 5000 ft.

*Westringia.*
W. senifolia (F. v. M.).
At 3000 ft.

*Ajuga.**
A. australis (Br.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.

*Teucrium.**
T. corymbosum (Br.). T., N.S.W., S.A., Q.
Ascends to 2500 ft.

VERBENACEÆ.

*Verbena.*
V. officinalis (Linn.). T., N.S.W., S.A., Q.
Ascends to 2000 ft.

EPACRIDEÆ.

*Styphelia.*
S. humifusa (Pers.). T., N.S.W., S.A., W.A.
At 2200 ft.
S. lanceolata (Sm.). T., N.S.W., Q.
Ascends to 4000 ft.
S. collina (Lab.). T., N.S.W., S.A.
Ascends to 5000 ft., Mt. Bogong.
S. glacialis (F. v. M.).
At 5000 to 6000 ft.
S. virgata (Lab.). T., N.S.W., S.A.
Ascends to 4000 ft.
S. montana (F. v. M.). T., N.S.W.
At 4000 ft.
S. Macræi (F. v. M.). N.S.W.
Ascends to 5000 ft.
S. ericoides. T. N.S.W., S.A., Q.
At 3000 to 4000 ft.
S. biflora (Spren.). N.S.W., Q.
Ascends to 3000 ft.
S. Fraseri (F. v. M.). T., N.S.W.
Ascends to 3000 ft.
S. juniperina (Spren.). N.S.W., Q.
Ascends to 4000 ft.
S. serrulata (Lab.). T., N.S.W., S.A.
Ascends to 4000 ft.
S. scoparia (Sm.). T., N.S.W.
Ascends to 3000 ft.
S. apiculata
Ascends to 2000 ft.

*Brachyloma.*
B. daphnoides (Ben.). T., N.S.W., S.A., Q.
At 2000 to 4000 ft.

*Trochocarpa.*
T. Clarkei (F. v. M.).
Ascends to from 4000 to 5000 ft.
T. pumila (F. v. M.). T., N.S.W.
At 3000 to 5000 ft., Mt. Bogong.

*Epacris.*
E. impressa (Lab.). T., N.S.W., S.A.
Ascends to 4500 ft.

*Epacris—continued—*
E. petrophila (H.). T., N.S.W.
Alpine ; at 4000 to 6000 ft., Mt. Bogong.
E. paludosa (Br.). N.S.W.
2000 to 5000 ft.
E. heteronema (Lab.) T., N.S.W.
Sub-alpine ; at 4000 to 5000 ft.
E. serpyllifolia (Br.). T., N.S.W.
Alpine ; at 6000 ft., Mt. Bogong.
E. microphylla (Br.). T., N.S.W., S.A., Q.
At 3000 to 4000 ft.
*Sprengelia.*
S. incarnata (Sm.). T., N.S.W., S.A.
Ascends to 2000 ft.
*Richea.*
R. Gunnii (H.). T.
Alpine ; at 4000 to 6000 ft. in Sphagnum beds, Mt. Bogong.

### ERICACEÆ.

*Gaultiera.*
G. hispida (Br.). T., N.S.W.
At 4000 to 5000 ft.
*Wittsteinia.*
W. vacciniacea (F. v. M.).
Restricted at 4500 to 5500 ft.

## MONOCOTYLEDONES.

### CALYCEÆ PERIGYNÆ.

### ORCHIDEÆ.

*Dendrobium.*
D. speciosum (Sm.). N.S.W., Q.
Ascends to 3000 ft.
D. striolatum (Reich.). N.S.W.
Ascends to 2000 ft.
*Dipodium.*
D. punctatum (Br.). T., N.S.W., S.A., Q., W.A., N.A.
At 2000 to 4500 ft., Mt. Bogong.
*Spiranthes.*
S. australis (Lind.). T., N.S.W., S.A., Q., N.Z., China, Ind., Siberia.
At 3000 to 4000 ft.
*Thelymitra.*
T. ixioides (Swartz). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
T. aristata (Lind.). T., N.S.W., S.A., W.A.
Ascends to 4000 ft.
T. longifolia (R. and G. Forster). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.
T. antennifera (H.). T., S.A., W.A.
Ascends to 2000 ft.
*Diuris.*
D. punctata (Sm.). N.S.W., S.A.
Ascends to 3000 ft.
D. maculata (Sm.). T., N.S.W., S.A., Q.
6 in. to 1 ft. high ; ascends to 3000 ft.

*Diuris—continued—*

D. pedunculata (Br.). T., N.S.W., S.A.
Ascends to 5000 ft.

D. sulphurea (Br.). T., N.S.W., S.A.
Ascends to 3000 ft.

D. longifolia (Br.). T., S.A., W.A.
Ascends to 4000 ft.

*Prasophyllum.*

P. patens (Br.). T., N.S.W., S.A., Q.
At 2000 to 4000 ft.

P. fuscum (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Microtis.*

M. porrifolia (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.

*Corysanthes.*

C. fimbriata (Br.). N.S.W.
Ascends to 2000 ft.

*Pterostylis.*

P. curta (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

P. nutans (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

B. nana (Br.). T., S.A., W.A.
Ascends to 2000 ft.

P. cucullata (Br.). T., S.A.
Ascends to 2500 ft.

*Caladenia.*

C. Menziesii (Br.). T., S.A., W.A.
Ascends to 4000 ft.

C. Patersoni (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 4200 ft.

C. latifolia (Br.). T., N.S.W., S.A., W.A.
Ascends to 2200 ft.

C. suaveolens (Reich.). T., N.S.W.
Ascends to 2000 ft.

C. carnea (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Glossodia.*

C. major (Br.). T., N.S.W., S.A., Q.
At 2000 to 4000 ft.

C. minor (Br.). N.S.W., Q.
Ascends to 4000 ft.

IRIDEÆ.

*Diplarrhena.*

D. Moræa (Lab.). T., N.S.W.
Ascends to 2000 ft.

*Patersonia.*

P. longiscapa (Sweet.). T., S.A.
Ascends to 2100 ft.

P. sericea (Br.). N.S.W., Q.
Ascends to 3000 ft.

AMARYLLIDEÆ (HYPOXIDEÆ).

*Hypoxis.*

A. hygrometrica (Lab.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.

## CALYCEÆ HYPOGYNÆ.

### LILIACEÆ.

*Smilax.*
S. australis (Br.). N.S.W., Q., N.A.
Ascends to 3000 ft.

*Drymophila.*
D. cyanocarpa (Br.). T., N.S.W.
Ascends to 4000 ft.

*Dianella.*
D. tasmanica (H.). T., N.S.W.
Ascends to 6000 ft.; most luxuriant at 5000 ft., Mt. Kosciuska slopes.
D. longifolia (Br.). T., N.S.W., S.A.
Ascends to 2800 ft.
D. revoluta (Br.). T., N.S.W., S.A., Q., W.A.
At 3000 to 4000 ft.

*Eustrephus.*
E. Brownii (F. v. M.). N.S.W., Q.
Ascends to 3000 ft.

*Astelia.*
A. alpina (Br.). T., N.S.W.
Alpine; at 4000 to 5000 ft.

*Wurmbea.*
W. dioica (F. v. M.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

*Bulbine.*
B. bulbosa (Haworth). T., N.S.W., S.A., Q.
Ascends to 3000 ft.

*Thysanotus.*
T. tuberosus (Br.). N.S.W., S.A., Q., N.A.
Ascends to 3500 ft.
T. Patersoni (Br.). T., N.S.W., S.A., W.A.
Ascends to 3000 ft.

*Cæsia.*
C. vittata (Br.). T., N.S.W., S.A., Q.
At 3000 to 4000 ft.

*Tricoryne.*
T. elatior (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.

*Stypandra.*
S. glauca (Br.). N.S.W., Q., W.A.
Ascends to 4000 ft.
S. cæspitosa (Br.). T., N.S.W., Q.
Ascends to 3000 ft.

*Xerotes.*
X. longifolia (Br.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

*Xanthorrhæa.*
X. minor (Br.). T., N.S.W., S.A.
Ascends to 2500 ft.
X. australis (Br.). T.
Ascends to 3000 ft.

### TYPHACEÆ.

*Typha.*
T. angustifolia (Linn.). T., N.S.W., S.A. Q., W.A., N.A.
Ubiquitous; ascends to 3000 ft.

*Sparganium.*
S. angustifolium (Br.). N.S.W., Q.
Ascends to 3000 ft.

FLUVIALES (ALISMACEÆ).

*Triglochin.*
T. mucronata (Br.). S.A., W.A.
Ascends to 2000 ft.
*Potamogeton.*
P. natans (Linn.). T., N.S.W., S.A., Q., W.A.
Ubiquitous; at 2500 ft.
P. crispus (Linn.). N.S.W., S.A., Q., N.A.
Ascends on swamps up to 3000 ft.

JUNCACEÆ.

*Luzula.*
L. campestris (Can.). T., N.S.W., S.A., Q., W.A.
Ubiquitous; ascends to 5000 ft., Mt. Bogong.
*Juncus.**
J. falcatus (Meyer). T., N.S.W.
Sub-alpine; ascends to 5000 ft.
J. bufonius* (Linn.). T., N.S.W., S.A., Q., W.A.
Ubiquitous; ascends to 4000 ft.
J. communis (Meyer). T., N.S.W., S.A., Q., W.A.
Ubiquitous; ascends to 4000 ft.
J. pallidus (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 2000 ft.
J. prismatocarpus (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 4000 ft.

RESTIACEÆ.

*Aphelia.*
A. Pumilio (F. v. M.). T.
Ascends to 5000 ft.
*Centrolepis.*
C. aristata (Rœmer and Schultes). T., N.S.W., S.A., W.A.
Ascends to 2000 ft.
C. strigosa (Rœmer and Schultes). T., N.S.W., S.A., W.A.
Ascends to 6000 ft.
C. videns.
Ascends to 4000 ft.
*Restio.*
R. australis (Br.). T., N.S.W.
Sub-alpine; at 3000 to 6000 ft.
R. tetraphyllus (Lab.). T., N.S.W., S.A., Q.
Ascends to 2000 ft.
*Calostrophus.*
C. lateriflorus (F. v. M.). T., N.S.W., S.A., Q.
Ascends to 6000 ft., Mt. Bogong.

ACALYCEÆ HYPOGYNÆ.

CYPERACEÆ.

*Kyllingia.*
K. intermedia (Br.). N.S.W., S.A., Q.
Ascends to 2000 ft.
*Cyperus.*
C. Eragrostis (Vahl.). N.S.W., S.A., Q.
Ascends to 2500 ft.

*Cyperus—continued—*
C. globosus (Allioni). Q.
Ascends to 3000 ft.
C. lucidus (Br.). T., N.S.W., S.A., Q., N.A.
At 3000 to 4000 ft.

*Heleocharis* (*Elæocharis*).
H. sphacelata (Br.). T., N.S.W., S.A., Q., N.A., N.Z., Pacific.
Ascends to 3000 ft.
H. acuta (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

*Scirpus.*
S. crassiusculus (H.). T., N.S.W.
At 3500 ft.
S. cartilagineus (Spr.). T., N.S.W., S.A., Q., W.A
Ascends to 200 ft.
S. polystachyus (F. v. M). N.S.W.
Ascends to 3000 ft.

*Oreobolus.*
O. Pumilio (Br.). T., N.S.W., N.Z.
Alpine ; at 6000 to 7000 ft.

*Carpha.*
C. alpina (Br.). T., N.S.W.
At 5000 to 6000 ft.

*Schœnus.**
S. brevifolius (Br.). N.S.W., S.A., Q., W.A.
At 3000 ft.

*Lepidosperma.*
L. longitudinale (Lab.). T., N.S.W., S.A., W.A.
Ascends to 2000 ft.
L. concavum (Br.). T., N.S.W., S.A., Q., N.Z.
At 2000 to 4000 ft.
L. lineare (Br.). T., N.S.W., S.A.
At 3000 to 4000 ft.
L. tortuosum (F. v. M.).
Ascends to 2000 ft.
L. filiforme (Lab.). T., N.S.W., S.A.
Sub-alpine ; ascends to 3000 ft.

*Cladium.**
C. Mariscus (Br.). N.S.W., S.A., Q., N.A.
Ubiquitous ; ascends to 3000 ft.
C. teretifolium (Br.). N.S.W., Q.
Ascends to 2000 ft.
C. Gunnii (H.). T., N.S.W., S.A.
Ascends to 3000 ft.

*Caustis.*
C. flexuosa (Br.). N.S.W., Q., N.A.
Ascends to 2000 ft.

*Uncinia.*
U. tenella (Br.). T.
At 3000 to 4000 ft.
U. riparia (Br.). T., N.S.W.
Sub-alpine ; ascends to 3000 ft.

*Carex.**
C. cephalotes (F. v. M.). N.S.W.
Ascends to 3000 ft.
C. acicularis (Boott). T., N.S.W.
At 4000 to 6000 ft. ; Mt. Bogong, 5000 ft.

*Carex*—continued—*

C. inversa (Br.). T., N.S.W., S.A., Q., W.A., N.Z.
At 2000 to 4000 ft.

C. canescens (Linn.). N.S.W.
Ascends to 5000 ft.

C. echinata (Murray). N.S.W.
Ascends to 4500 ft.

C. hypandra (F. v. M.). N.S.W.
Ascends to 2000 ft.

C. acuta (Linn.). N.S.W., Q.
Ascends to 2000 ft.

C. Buxbaumii (Wahlen). N.S.W.
At 3000 to 5000 ft., Mt. Bogong.

C. Preissii (Nees). W.A.
At 2000 to 4000 ft.

C. gunniana (Boott). T., N.S.W., S.A.
Ascends to 5000 ft.

C. alsophila (F. v. M.).
Ascends to 4000 ft.

C. longifolia (Br.). T., N.S.W., Q.
Ascends to 4000 ft.

C. Pseudo-Cyperus (Linn.). T., N.S.W., S.A., Q., W.A.
Ascends to 5000 ft., Mt. Bogong.

GRAMINEÆ.

*Panicum.*

P. sanguinale. N.S.W., Q., W.A., N.A.
Ascends to 3000 ft.

P. melananthum. N.S.W., Q.
Ascends to 3000 ft.

*Spinifex.*

S. hirsutus. S.A., T., N.S.W., Q., W.A., N.Z.
Ascends to 2000 ft.

*Hemarthria.*

H. compressa. S.A., T., N.S.W., Q., W.A
At 2000 to 3000 ft.

*Andropogon.**

A. refractus. N.S.W., Q., N.A.
Ascends to 2000 ft.

A. montanus. N.S.W., Q., N.A.
Ascends to 2000 ft.

*Anthistiria.*

A. ciliata. S.A., T., N.S.W., Q., W.A., N.A.
(Kangaroo grass).
Ascends to 6000 ft.

*Ehrharta.*

E. juncea. T., N.S.W.
Ascends to 4000 ft.

*Hierochloe.*

H. redolens. T., N.S.W., N.Z., Antarctic, America.
Ascends to 5000 ft.

H. rariflora. T., N.S.W.
At 2000 to 3000 ft.

*Stipa.*

S. setacea. S.A., T., N.S.W., Q.
Ascends to 4000 ft.

S. scabra. S.A., N.S.W., Q., W.A.
Ascends to 4000 ft.

*Dichelachne.*
D. crinita. S.A., T., N.S.W., Q., W.A., N.Z.
At 2000 to 3000 ft.
*Pentapogon.*
P. Billardieri. S.A., T., N.S.W.
Ascends to 3000 ft.
*Echinopogon.*
E. ovatus. S.A., T., N.S.W. Q., W.A., N.Z.
Ascends to 5000 ft.
*Agrostis.*
A. Muelleri. N.S.W.
At 5000 to 6000 ft.
A. scabra. S.A., T., N.S.W.
Sub-alpine ; ascends to 4500 ft.
A. Solandri. S.A., T., N.S.W., Q., W.A.
Ascends to 4000 ft.
A. quadriseta. S.A., T., N.S.W., Q., W.A.
Ascends to 3000 ft.
A. cylindrica. W.A.
Ascends to 2000 ft.
A. frigida. T., N.S.W.
Ascends to 5000 ft.
A. nivalis. N.S.W.
At 5000 to 6000 ft.
*Aira.**
A. cæspitosa. S.A., T., N.S.W.
Ascends to 4000 ft.
*Trisetum.**
T. subspicatum. T., N.S.W. Antarctic, etc.
At 4000 to 7200 ft. ; 6500 ft., Mt. Bogong.
*Danthonia.*
D. penicillata. S.A., T., N.S.W., Q., W.A.
At 5000 to 6500 ft., Mt. Bogong.
D. robusta. N.S.W.
Ascends from 4000 to 6000 ft., Mt. Bogong.
D. nervosa. S.A., T., N.S.W., W.A.
Ascends to 3000 ft.
*Poa.**
P. Billardieri. S.A., T., W.A.
Ascends to 3000 ft.
P. cæspitosa. S.A., T., N.S.W., Q., W.A.
Ascends to 6000 ft., Mt. Bogong.
P. dives.
Very restricted species, stems 12 ft. high, at 4000 to 5000 ft.
P. australis.
At 6000 to 7000 ft.
*Festuca.**
F. hookeriana. T., N.S.W.
Sub-alpine ; at 3000 to 5000 ft.
*Bromus.**
B. arenarius. S.A., N.S.W., Q., W.A.
Ascends to 4000 ft.
*Agropyron.**
A. scabrum. S.A., T., N.S.W., Q., W.A.
Ascends to 3000 ft.
A. pectinatum. T., N.S.W.,
Ascends to 4000 ft.
*Total*—S.A. 18, T. 23, N.S.W. 31, Q. 17, W.A. 16, N.A.

The following introduced species are also now abundant:—Dactylis glomerata, Briza major, B. minor, Holcus lanatus, Lepturus incurvatus, Hordeum murinum, Anthoxanthum odoratum, Lolium perenne, L. temulentum, Bromus sp., Phalaris minor, Poa annua, Pennisetum italicum.

## GYMNOSPERMÆ.

### CONIFERÆ.

*Nageia.*
N. alpina (F. v. M.). T., N.S.W.
Restricted to 5000 to 6000 ft.; a small shrub.

## ACOTYLEDONES VASCULARES.

### RHIZOSPERMÆ.

*Azolla.*
A. pinnata. (Br.). N.S.W., S.A., Q.
Ascends to 4000 ft.

### LYCOPODINEÆ.

*Lycopodium.*
L. Selago (Linn.). T., N.S.W.
At 6000 to 7000 ft.; 6500 ft., Mt. Bogong.
L. clavatum (Linn.). T., N.S.W.
At 4000 to 5000 ft.
L. laterale (Br.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.
L. densum (Lab.). T., N.S.W., S.A.
Ascends to 4000 ft.

*Selaginella.*
S. preissiana (Spring.). T., N.S.W., S.A., Q., W.A.
Ascends to 6000 ft.
S. uliginosa (Spring.). T., N.S.W., S.A., Q.
Ascends to 2000 ft.

### FILICES.

*Ophioglossum.*
O. vulgatum (Bauhin). T., N.S.W., S.A., Q., W.A.
Ascends to 5000 ft.

*Botrychium.*
B. lunaria (Swartz). T., N.S.W.
Ascends to 5000 ft.
B. ternatum (Swartz). T., N.S.W., Q.
Ascends to 3000 ft.

*Trichomanes.*
T. venosum (Br.). T., N.S.W., Q.
Ascends to 2000 ft.

*Hymenophyllum.*
H. nitens (Br). T., N.S.W., Q.
Ascends to 2000 ft.
H. tunbridgense (Sm.). T., N.S.W., Q.
Ascends to 4000 ft.

*Gleichenia.*
G. circinata (Swartz). T., N.S.W., S.A., Q., N.A.
Ascends to 4000 ft.
G. dicarpa (Br.). T., N.S.W., Q.
Ascends to 4800 ft., Mt. Bogong.
G. flabellata (Br.). T., N.S.W., Q.
Ascends to 4000 ft.

*Osmunda.*
O. barbara (Thun.). T., N.S.W., S.A., Q.
Ascends to 2000 ft.

*Alsophila.*
A. australis (Br.). T., N.S.W., Q.
Ascends to 3000 ft.

*Dicksonia.*
D. Billardieri (F. v. M.). T., N.S.W., S.A., Q.
Ascends to 4000 ft., gullies north side of Mt. Bogong.
D. davallioides (Br.). N.S.W., Q.
Ascends to 3500 ft.

*Davallia.*
D. dubia (Br.). T., N.S.W., Q.
Ascends to 4000 ft.

*Lindsaya.*
L. linearis (Swartz). T., N.S.W., S.A., Q., W.A.
Ascends to 3000 ft.

*Adiantum.*
A. æthiopicum (Linn.). T., N.S.W., S.A., Q., W.A.
Ascends to 6000 ft.

*Cheilanthes.*
C. tenuifolia (Swartz). T., N.S.W., S.A., Q., W.A., N.A.
Ascends to 4000 ft.

*Pteris.*
P. falcata (Br.). T., N.S.W., Q.
Ascends to 4000 ft.
P. umbrosa (Br.). N.S.W., Q.
Ascends to 2000 ft.
P. arguta (Aiton). T., N.S.W., Q.
Ascends to 3000 ft.
P. aquilina (Linn.). T., N.S.W., S.A., Q., W.A.
Ubiquitous ; ascends to 5000 ft.
P. incisa (Thun.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.
P. comans (Forster). T., N.S.W., Q.
Ascends to 2000 ft.

*Lomaria.*
L. discolor (Will.). T., N.S.W., S.A., Q.
Ascends to 5000 ft.
L. lanceolata (Spreng.). T., N.S.W., S.A.
Ascends to 4000 ft.
L. alpina (Spreng.). T., N.S.W.
From 3000 to 7000 ft., Mt. Kosciusko ; 6500 ft., Mt. Hotham.
L. fluviatilis (Spreng.). T., N.S.W.
Ascends to 5000 ft.
L. capensis (Will.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.

*Blechnum.*
B. cartilagineum (Swartz). N.S.W., Q.
Ascends to 2000 ft.

*Woodwardia.*
W. aspera (Mett.). N.S.W., Q.
Ascends to 3000 ft.
*Asplenium.*
A. trichomanes (Linn.). T., N.S.W.
Ascends to 5000 ft.
A. flabellifolium (Cav.). T., N.S.W., S.A., Q., W.A.
Ascends to 6000 ft.
A. hookerianum (Colen.). N.S.W.
Ascends to 4000 ft.
A. bulbiferum (Fors.). T., N.S.W., S.A., Q.
Ascends to 4000 ft.
A. umbrosum (Sm.). T., N.S.W.
Ascends to 2000 ft.
*Aspidium.*
A. aculeatum (Swartz). T., N.S.W., S.A., Q.
Ascends to 2000 ft.
A. capense (Will.). T., N.S.W.
Ascends to 3000 ft.
A. decompositum (Spreng.). T., N.S.W., S.A., Q.
Ascends to 3000 ft.
A. hispidum (Swartz). T.
Ascends to 3000 ft.
*Polypodium.*
P. australe (Mett.). T., N.S.W. Q.
Ascends to 2000 ft.
P. pustulatum (Forster). T., N.S.W., Q.
Ascends to 3000 ft.
P. grammitidis (Br.). T., N.S.W.
Ascends to 2000 ft.
*Grammitis.*
G. rutifolia (Br.). T., N.S.W., S.A., Q., W.A.
Ascends to 6300 ft., Mt. Bogong.

## MUSCINEÆ.

### MUSCI.

#### 1. SPHAGNACEÆ.

*Sphagnum.**
S. *cymbifolium.
Ascends to 5000 to 6000 ft.

#### 2. POLYTRICHACEÆ.

*Atrichum.**
A. *(Catharinea) Muelleri.
At 4000 ft., at Grant.
*Pogonatum.*
P. alpinum.
At 5000 ft.
*Polytrichum.**
P. *juniperinum.
At 4000 ft.
P. *commune.
Ascends to 5000 ft., Dargo High Plains.
*Dawsonia.*
D. polytrichoides.
At 3000 ft.
D. superba.
At 4000 ft.

### 3. DICRANACEÆ.

*Dicranella.**
D. rufo-aurea.
Ascends to 5000 ft.
*Dicnemon.*
D. calycinum.
Ascends to 3000 ft.
*Blindia.**
B. robusta.
Ascends to 7000 ft.; Mt. Bogong, 6500 ft.
*Dicranum.**
D. dicarpum.
At 2000 to 3500 ft.
D. Billardieri.
At 2000 ft.
D. punctulatum.
At 2000 ft.
D. Sullivanii.
Ascends to 2000 ft.
*Ceratadon.**
C. *purpureus (*var.* australis).
Ascends to 4000 ft.
*Campylopus.**
C. introflexus.
Ascends to 6000 ft.
C. torquatus.
Ascends to 5000 ft.
C. Martensi.
Ascends to 4000 ft.
*Rhynchostegium.*
R. patulum.
R. distratum.
R. cucullatum.
R. laxatum.
R. pseudo-murale.
R. pseudo-Teesdalii.
R. tenuifolium.
R. subclavatum.
R. densifolium (? dentiferum).
*Pleuridium.**
P. curvulum.

### 4. SKITOPHYLLACEÆ (FISSIDENTACEÆ).

*Fissidens.**
F. rigidulus.
F. semilimbatus.
F. tenellus.
F. perpusillus.
F. *adiantoides. N.Z.
F. asplenioides. N.Z.
F. Sullivanii.

### 5. GRIMMIACEÆ.

*Grimmia.**
G. *apocarpa.
At 3000 ft.
G. lanuginosa.
At 7000 ft., Mt. Kosciusko.

*Grimmia*—continued—*
G. Sullivanii.
At 6500 ft.
G. *leucophæa.
At 3000 ft.
G. cylindropyxis.
At 4000 ft.
G. australis.
At 3500 ft., Omeo.
G. mutica.
At 3000 ft.
G. austro-funalis.
At 3000 ft.
G. cyathocarpa.
At 3500 ft.
G. flexifolia.
At 3000 ft.
G. procumbens.
At 3000 ft.
G. cygnicolla (syn. G. pulvinata); *var.* obtusa.
At 4000 ft.
*Hedwigia.**
H. *ciliata.
*Leucobryum.**
L. candidum.
L. conocladum.

6. TORTULACEÆ.

*Phascum.**
P. disrumpens.
3500 to 4000 ft.
*Weisia.**
W. nudiflora.
3000 to 4000 ft.
W. flavipes.
3000 to 4000 ft.
*Tortula.**
T. rubra.
3000 to 4000 ft., Omeo.
*Barbula.**
B. propinqua.
B. microphylla.
B. lamellosa.
B. brevisetacea.
B. sullivaniana.
B. vesiculosa.
B. calycina.
*Trichostomum.**
T. leptotheca.
T. pseudopiliferum.
T. adjusta.
T. nervosum.
T. crassinerve.
T. papillosum.
T. Latrobeana.

7. ORTHOTRICHEÆ.

*Orthotrichum.*
O. laterale.
Ascends to 3000 ft.

*Apalodium.*
A. lanceolatum.
Ascends to 5000 ft.
*Zygodon.*
Z. brachyodus.
Ascends to 6000 ft.
Z. Brownii.
Ascends to 5000 ft.
Z. minutus.
At 6500 ft.
*Dissodon.*
D. nova-valesia.
Ascends to 3500 ft.
*Rhystogoneum.*
R. Hookeri.
R. gracellimii.
R. Muelleri.

### 8. FUNARIÆ.

*Entosthodon.*
E. laxus.
Ascends to 3000 ft.
E. minuticaulis.
Ascends to 3000 ft.
E. apophysatus.
Ascends to 3000 ft.
E. Taylori.
E. Sullivanii.
*Funaria.*
F. hygrometrica.
At 3000 ft.
F. pulchridens.
At 3000 ft.
*Physcomitrium.*
P. subserratum.
Ascends to 3600 ft.
P. subspicatum.

### 9. BARTRAMIACEÆ.

*Bartramia.**
B. hampeana.
At 2000 to 7000 ft.
B. patula.
At 6500 to 7000 ft.
B. erecta.
At 6500 to 7100 ft.
B. Kosciuskii.
At 7000 ft.
B. pygmæola.
At 6500 ft.
B. austro-pyrenaceæ.
At 3000 ft.
*Philonotis.**
P. adpressa.
At 4000 ft.
P. fertilis.
Ascends to 6000 ft., Mt. Bogong.

*Breutelia.**
B. affinis.
Ascends to 4500 ft.
B. commutata.
Ascends to 6500 ft.
*Conostomum.**
C. curvirostre.
At 3000 to 4000 ft.

10. BRYACEÆ.

*Bryum.**
B. breviramulosum.
Ascends to 3000 ft.
B. subrotundifolium.
B. pyrothecium.
Ascends to 3000 ft.
B. nutans.
Ascends to 3500 ft.
B. crysoneurum.
At 4000 to 6000 ft.
B. crassum.
B. crassinervium.
B. attenuatum.
B. Billardieri.
3000 to 4000 ft.
B. subleptothecium.
B. leptothecium.
B. inæquale.
B. acithecium.
B. Sullivanii.
B. altisetum.
B. robustum.
*Cyathophorum.*
C. pennatum.
At 3500 ft.

11. CRYPHÆACEÆ.

*Cryphæa.**
C. squarrulosa.
C. muelleriana.

12. NECKERACEÆ.

*Neckera.**
N. hymenodontea.
At 3500 ft.
N. aurescens.
*Lepyrodon.*
L. Lagurus.
3000 to 4000 ft.

13. HOOKERIACEÆ.

*Hookeria.*
H. nigella.
At 4000 ft.
*Pterygophyllum.**
P. nigellum.
At 3000 ft.

### 14. LEUCODONTACEÆ.

*Porotrichum.**
P. divulsum.
P. deflexum.
P. ramulosum.
P. clandestinum.

### 15. LESKEACEÆ.

*Thuidium.**
T. plumulosiforme.
At 3000 ft.
T. suberectum.
*Bartrela.*
*Hypopterygium.*
H. concinnum.
H. Muelleri.
H. novæ-zealandiæ.
H. ciliatum.
*Sauloma.*
S. tenella.

### 16. SEMATOPHYLLEÆ.

*Rhaphidorhynchum.*
R. homomallum.
R. calidoides.

### 17. STEREODONTEÆ.

*Plagiothecium.*
P. denticulatum.
At 3500 ft.
*Amblystegium.*
A. convolutifolium.
At 4000 ft.
A. riparium.
At 4500 ft.
*Acrocladium.*
A. auriculatum.
At 3500 ft.
A. politum.
*Stereodon.*
S. cupressiformis.
At 3500 ft.

### 18. HYPNACEÆ.

*Hypnum.**
H. (Ptycomnion) aciculare.
At 3000 ft.
*H. cupressiforme.
At 4000 ft.
H. (Cupressina) sigmangium.
At 3800 ft.
H. Kosciuskii.
At 7000 ft.
*Brachythecium.**
B. austro-alpinum.
B. paradoxum.

### HEPATICÆ.

*Marchantia.*
M. polymorpha.
*Timbrya* (sp.).

### MISCELLANEOUS SPECIES IN THE COLLECTION.

*Macromitrium.*
M. microstomum.
M. Muelleri.
M. erosulum.
*Mielichhoferia.*
M. Sullivanii.
M. microdonta.
M. australis.
*Leptostomum.*
L. inclinans.
L. flexipile.
*Carovaglia.*
C. sciuroides.
*Meteorium.*
M. fulvum.
M. molle.
M. Billardieri.
*Harrisonia.*
H. australis.
*Braunia.*
B. erosa.
*Eremodon.*
E. octoblepharis.
*Astomum.*
A. krauseanum.
*Leptotrichum.*
L. Muelleri.
*Leptangium.*
L. repens.

## THALLOPHYTÆ.

### LICHENES.

*Collema.**
C. læve. *Forms* granulatum and isidiosum.
C. plumbeum.
C. leucocarpum.
*Synechoblastus.*
S. senecionus.
S. leucocarpus. *Var.* minor.
*Leptogium.*
*L. lacerum. *Var.* intermedium.
*L. tremelloides. *Var.* agurium.
L. victorianum.
L. pecten.
L. inflexum. *Var.* limbatum.
*L. scotinum.
*Myriangium.*
M. duriæi.
M. dolichosporum.
*Sphinctrina.*
S. microcephalata.
*Calicium.**
C. chrysocephalum. *Var.* filari.
C. niveum.
C. Victoriæ.
C. parvulum.

*Calicium*—continued.*
C. roseo-albidum.
C. capillare.
C. biloculare.
C. nigrum. *Var.* minutum.
*C. curtum.
C. trachelenum. *Var.* elattosporum.
*C. hyperellum. *Vars.* validus and perbreve.
C. ochrocephala.
C. gracilenta. *Var.* leucocephala.

*Trachylia.*
T. lecanorina.

*Sphærophoron.*
S. australe. *Var.* proliferum.

*Gomphillus.*
G. baceomyceoides.

*Bæomyces.**
B. fungoides.
B. heteromorphus.

*Thysanothecium.*
T. hyalium. *Vars.* squamulosum and entortum.
T. Hookeri.

*Cladonia.**
C. pyxidata. *Var.* marginatus. Ascends to 3000 ft.
*C. macilenta.
C. corniculata.
C. aggregata.
C. cenalen.
*C. furcata. Ascends to 3000 ft.
C. retipora. Ascends to 3000 ft.
*C. gracilis.
C. degenerans.
*C. crispata.
C. xanthoclada.
C. cornucopioides.
C. verticillata. Ascends to 3500 ft.
C. cenotea. Ascends to 2500 ft.

*Parmelia.**
P. saxatilis.
P. conspersa.
P. perlata.
P. meizospora. Ascends to 2000 ft.
P. reparata.
P. oleraceum.
P. aleurites.
P. Borreri.
*P. pertusa.
P. australiensis.
*P. caperata. Ascends to 3500 ft.
P. alpicola.
P. physodes.
P. Mougeotii.

*Stictina.**
S. crocata.

*Physcia.*
P. flabiensis.

*Cladina.**
C. aggregata (clalhrina ?).

*Peltigera.**
  P. dolichortiza.
  P. distichorhysa.
  *P. polydactyla.
*Nephronium.*
  N. cellulosum.
  N. melaxanthus.
*Sticta.*
  S. Freycinetii.
  S. damæcornis.
  S. Fovescala.
*Arthonia* sp.*
*Endocarpon.*
  E. samptelli.
*Chiodicton.*
  C. stromatheca.
*Ramalina.*
  R. minuscula.
  R. complanata.
  R. maculata.
  R. implanta.
*Grapshin* (?).
  G. laurdenia.
*Electra.*
  E. australiensis.
*Lecidea.**
  L. comaterum.
  L. Victoriæ (Braloriæ).
*Bealina.*
  B. Victoriæ.
*Lecanora.**
  L. leucopsida.
*Lichina.**
  L. confinis.
*Neuropogon.*
  N. melaxanthum.
*Usnea.**
  U. barbata.
*Siphula.*
  S. Muelleri.
*Stereocaulon.*
  S. ramulosum.
  S. proximus.
*Pertusaria* sp.*
*Physcia.**
  P. parietina.
  P. flabiensis.
  P. chrysophthalma.
*Graphis.**
  G. glaucoderma.
*Theloschistis.*
  T. velifer.
*Umbilicaria.**
  U. cylindrica.
  U. polyphylla.
  U. antharcina.

*Psoroma.*
P. hypnorum.
P. paleacum.
*Placodium.*
P. elegans.
*Urceolaria* sp.
*Bruellia.*
B. myriocarpa.
B. geographica.
*Verrucaria* sp.*
*Heterothecium* sp.
*Hymenocharti.*
H. purpurea.
*Corticium.*
C. læve.
*Calocera.*
C. corusa.
*Cornicularia* sp.
47 *Genera.* 95 *Species.*

FUNGI AND MICRO-FUNGI.

*Æcidium.**
Æ. Ranunculacearum.
*Puccinia.**
P. agenophoræ.
P. Malvacearum.
*Uredo.**
U. Bulbinea.
U. Cichoracearum.
*Nectria.**
N. ferruginea.
*Ustilago.**
U. Digitariæ.
*Asteroma.**
A. Rosæ.
*Leptoria* sp.
*Polyporus.**
P. ochroleraceus.
P. oblectans.
P. (Placoderus) australis.
P. (Placoderus) igniarius.
P. compressus.
*Dædalea.*
D. unicolor.
*Pleodrictyon.*
P. gracile.
*Peziza.**
P. apiculata.
*Polysaccum.*
P. pisocarpium.
*Scleroderma.**
S. vulgare.
*Agaricus* *
A. scandens.
A. muellerianus.
A. fascicularis.
A. procerus.

*Agaricus—continued—*
*A. campestris.
*A. (Omphalia) umbelliferus.
*Lycoperdon.**
L. cælatum.
*Inoderma.*
I. arenarius.
*Cyathus.*
C. fimicola.
*Isaria.**
I. fuciformis.
I. umbrina.
*Bovista.*
B. lilacina.
*Nematogonium.*
N. aurantiacum.
*Pestalozziella.*
P. circulare.
*Patellaria* sp.
*Stereum.**
S. lobatum.
S. hirsutum.
S. elegans.
*Thelephora.**
T. pedicellata.

## Revised Note on Laminaria. By Thomas Berwick, St. Andrews.

(Read 9th July 1903.)

*Demonstrations of the Masked Chlorophyll in fronds of above, for Class purposes.*

(1) If a frond of *Laminaria* of any length—the longer the better—after being simply air-dried, be passed with moderate rapidity with both hands through an ordinary bat-wing or bunsen flame, at once the brown colouring matter (Phycophæin)[1] disappears, the discharge of a misty vapour accompanying the change.

(2) By placing a coin heated to the proper temperature on frond, and exerting pressure, a series of green impressions can be immediately produced. Metal stamps of various designs act similarly. To obtain printed impressions the letters require to stand well out.

(3) By playing a lens upon frond for a short time, green

[1] Botanical Microtechnique. By Dr. A. Zimmermann. Translated by J. E. Humphrey, S.D., 1896, p. 104.

spots are got, and there is a beautiful demonstration in miniature of the misty vapour making its escape.

(4) The Phycophæin retreats like a cloud before the heat (this is observable in the first experiment).

When a metal mould of an Ivy leaf is heated and pressed on the frond, one gets an impression of the same size as the mould well defined in green, and three minutes after removing metal, an outline beyond the contour line in pale green, which latter is surrounded by another outline in pale brown impinging on the natural brown.

(5) If a heated double split ring be applied on frond, the ring forms a light green circle, bordered on either side by a broad green band. Towards the periphery in three minutes the condition as in Ivy leaf is seen, a light green succeeded by a light brown ring appearing.

From the central brown area, corresponding with the hollow of the ring, similar phenomena occur in three minutes—a light brown ring next the brown (natural), and a light green ring beyond.

After an exposure to air of a few hours, and an afternoon and night wrapped up in paper, and thus excluded from atmospheric agency, the central brown (natural) area of the manipulated frond is surrounded by a green ring, and a brown occupies the place of the previous green ring.

Towards the periphery of the figure, one finds a green ring touching the natural brown of the frond, and within the green ring a circle of brown.

## Cowthorpe Oak. By John Clayton. Communicated by Dr. David Christison. (With Photo. Illustrations.)

(Read 12th March 1903.)

The oak tree at Cowthorpe, near Wetherby, is acknowledged to be the largest in diameter of all oaks that are known. It therefore commands an attention that is specially its own—as a king among men—and it is doubtful whether any other living tree has had as much written about it as it has, for wherever books on forestry in the English language are printed and read, so far has spread the fame of the Cowthorpe Oak.

Famous English trees and the records we have respecting them have furnished data to the scientific men of all countries; no other country being possessed of the double blessing of wonderful trees and reliable recorders. The recorders deserving to be remembered in connection with our subject are John Evelyn, Robert Marsham, H. Rooke, Dr. Hunter, J. G. Strutt, Loudon, and Empson. The records consist of a statement such as—that in a certain locality, on the date of writing, there was a tree of such a species, which girthed so many feet and inches at, say, 5 ft. from the ground; that the spread of the head was so many feet; the height so many feet; that the trunk was sound or not, as the case might be; and any other peculiarity. Statements like these would seem valueless to most people, and not worth recording, but being facts, scientific men can with them in after times prove or disprove theories of great interest and importance. One particular theory being De Candolle's, which claims for trees the possibility of an immortal life. Besides, the statements afford means of comparison, and without them it would not be known that some of the dimensions of the oak at Cowthorpe are larger than those of any other oak that is known.

John Evelyn was the first to make a number of records, and his "Sylva; or, Discourse of Forest Trees," published in 1664, was so popular that afterwards he was known as Sylva Evelyn. At present "Evelyn's Diary" is a more popular work; to his credit it may also be remembered that he was one of the founders of the Royal Society. It is only a little more than two hundred years since Evelyn wrote the "Sylva," and of the noteworthy trees which he mentioned there are only three living at the present time—the Yew at Crowhurst, the Great Chestnut at Tortworth, and the Greendale Oak in Welbeck Park, near Worksop.

The yew tree at Crowhurst, in Surrey, stands to the east of the ancient church of that place—in the graveyard. In records of Edward I.'s time the church is mentioned. Within the building there are monuments with a date as early as 1450, and several others without a date which must be earlier still, as they are of Saxon and Norman workmanship. Our oldest trees are generally near some church, and it seems as if the sacredness of the edifice helps to shelter

and preserve them. This yew is one of about half a dozen which very closely compete for the distinction of being the largest in Britain (Photo. No. 1). It girths 34 ft. 4 in. on the ground; at 3 ft. above the ground, 32½ ft.; and at 5 ft. above, 30 ft. The pieces of paper pinned to the trunk indicate the girthing places—3 ft. and 5 ft. above the ground. The foliage and twig growth of the tree are very healthy and vigorous, but the trunk is hollow, and is a mere shell. There is a door which admits to the cavity, which is seated all round, being quite large enough to hold a number of people, for it measures in diameter 8 ft. one way and 9 ft. 3 in. another. Since Evelyn's time, it would seem this tree has not increased in girth, for he then speaks of it as being about ten yards in compass. The Great Chestnut at Tortworth, in Gloucestershire, is a tree about which there has been much discussion. In summertime its head appears a dense mass of healthy foliage (Photo. No. 2). The trunk girths 49 ft. 2 in. at 4 ft. from the ground—the place indicated by the paper pinned to the tree. This tree is on the Earl of Ducie's estate, and is about a hundred yards away from another very old and beautiful church. In 1646, when John Evelyn recorded the measurements of the Greendale Oak, it was evidently in a flourishing condition. It was 88 ft. high, "the diameter of the head was 81 ft. from bough end to bough end," and was very fresh and sound. The Greendale Oak is in Welbeck Park, and belongs to the Duke of Portland. Visitors at the Dukeries will not see this tree unless they inquire for it specially, as it stands a little away from the ordinary drive, in an open glade (Photo. No. 3). A roadway was cut through the trunk in 1724, as a consequence, it is said, of an after-dinner bet of Henry, the first Duke of Portland. Since then it has been the custom of the successive dukes to pass through the roadway with their brides shortly after marriage. The height of the archway when newly made is given as 10 ft. 2 in. Now at the highest point it is only 9 ft. 3 in., and at the lowest it is only 8½ ft., thus it is evident that the trunk has shrunk considerably, and does not stand as high out of the ground as it did formerly. At present the trunk girths 30 ft. 1 in. at 4½ ft. from the ground, or at the place indicated by the paper which appears

in the photograph. The highest twig reaches an altitude of about 54 ft.

The observations of Robert Marsham were communicated to the Royal Society by Dr. Hales in the middle of the eighteenth century. He in various ways contributed to our knowledge of forest trees. His measurements of the Cowthorpe Oak were the earliest which were properly verified by bearing the date of the measurements, and the name of the measurer. Marsham was a Norfolk gentleman who travelled extensively in England at a time when travelling was not so easy, for besides visiting Cowthorpe and other places, his records respecting the Tortworth Chestnut show that he had wandered as far as Gloucestershire.

Dr. Alexander Hunter, of York, published an edition of Evelyn's "Sylva" in 1776, with copious notes, which form a very valuable addition. Dr. Hunter corresponded with Marsham and many prominent scientific men. In this way he collected his published information respecting large and noted trees. The yew trees near Fountains Abbey he may have measured, but the dimensions he gives of the Cowthorpe Oak must be of a date long before his time, for they do not agree either with the measurements of his contemporaries, or the proportions shown by his excellent print of the celebrated tree. Dr. Hunter's work has in all probability spread the fame of the Cowthorpe Oak more than that of others. His dimensions of the tree are always given in popular descriptions—perhaps because they are the largest,—but though it is likely they once were correct, they are so no longer, and in quoting them some explanation ought to be given, or certainly a very exaggerated idea will be formed of what the old tree is at present.

Major Rooke in 1790 published descriptions and sketches of Remarkable Oaks at Welbeck and in Sherwood Forest. The Greendale Oak and others are carefully drawn and described, but the tree which bears his name, and is called the "Major Oak," is not mentioned by him. He had heard of the Cowthorpe Oak through Mr. Marsham, but was ignorant of Dr. Hunter's work, though it had been published thirteen years before. This fact seems to show a slow circulation of books in those days.

Jacob George Strutt, who was a landscape painter, travelled throughout England and Scotland during 1822 and several years following, sketching and painting forest trees distinguished for their size and antiquity. He left us fifty beautiful and faithful pictures, as memorials of grand trees scattered all over our island.

J. C. Loudon published the "Arboretum Britannicum" in 1838. It is a work of eight volumes, consisting of prints and letter-press, illustrative of all the information which he could gather about trees. Ten thousand pounds sterling was the cost of the production, and the sale was so slow that all Loudon was worth had to be pledged to the publishers for payment. It is said, the work and anxiety connected with it shortened the life of the author. How very often is scientific enterprise, not only unremunerative, but attended with disastrous loss.

Charles Empson published a pamphlet on the Cowthorpe Oak in 1842. He, in conjunction with four others, visited the tree, and took minute particulars and measurements in January of the same year. These measurements, which seem to have been taken with extreme care, along with a truthful print (which accompanies his pamphlet), form an important link in the history of the oak from the time of Dr. Hunter to the present. Who Empson was it is impossible to tell now, or anything more about him than that his name will always be remembered in any really worthy account of the venerable tree.

In 1893, or fifty-one years after Empson, the investigations, measurements, photographs, etc., were made, which are the subject matter of this paper. Four times during that year the Cowthorpe Oak was visited—in January, April, June, and October—with a view of seeing the tree under the aspects of the various seasons, and collecting at each time as much local information as possible. Besides, pilgrimages have been made to the tree once or twice in each year since.

Cowthorpe is a small village about four miles north-east of Wetherby. It is within a bend of the river Nidd. The church there was built in 1458, and is regarded with much interest. The old oak is near the church, and again the proximity of the two suggests it as probable that the tree

may have received some protecting influence from the sacredness of the church. In a photograph of the tree from the north the church appears, and in that from the south the old manor house is seen. When the tree was seen for the first time it was in January, but the earlier photographs were taken in April (Photo. No. 4). From the photographs it will be readily understood that the first sight of the celebrated Cowthorpe Oak was a disappointment. It seemed merely a heap of decaying stumps and props. However, after having made a circuit of the trunk outside the palings, which are about 5 ft. high, the sense of disappointment about the old monarch gradually gave place to a feeling of respect. The diagram shows the dimensions of the tree in various ways. The measurements were taken very carefully on 16th June 1893, and when tabulated as they are on the subjoined table, they can be easily compared with the measurements of others. The comparison shows the dimensions of the tree have diminished since Dr. Hunter's measurements were taken. That the old tree as it decays should shrink and settle somewhat into the ground is natural, and the difference between the earlier and later measurements is due to this circumstance mainly.

TABLE OF MEASUREMENTS of the COWTHORPE OAK from the time when first recorded to 1893.

Measurements in Dr. HUNTER's edition of Evelyn's "Sylva," which must have been taken about 1700—

| | |
|---|---|
| Girth on ground | 78 ft. |
| Length of branch | 48 ft. |
| Height of tree | 80 ft. |

**1768.** ROBERT MARSHAM'S measurements—

| | |
|---|---|
| Girth 4 ft. above ground | 46½ ft. |
| ,, 5 ft. ,, | 36½ ft. |
| ,, 6 ft. ,, | 32 ft. 1 in. |

No hollow or cavity mentioned.

**1774.** Aug. THOMAS MAUDE'S measure. Had heard it to be 81 ft. 6 in. in girth, but his measure a few inches above ground was 54 ft. No cavity is mentioned. Wind storm in 1703 damaged the tree, but the leading branch was torn away in 1718.

**1776.** The date of Dr. HUNTER'S portrait of the tree. In the portrait no cavity appears, and none is mentioned in his letter-press description.

In **1829** Dr. JESSOP measured the tree, and the measurements are given by J. G. Strutt—

| | |
|---|---|
| Girth on ground | 60 ft. |
| ,, 3 ft. above ground | 45 ft. |
| Length of branch | 50 ft. |
| Circumference of branch | 8 ft. |
| Height of tree | 45 ft. |

Cavity big enough to hold 40 men, and hollow throughout to the top. Leaves are sessile, and acorns are on stalks.

**1829.** Oct. A cor. of J. C. LOUDON measures—

| | |
|---|---|
| Length of largest living branch, about | 48 ft. |
| Girth of branch 3 ft. from bole | $8\frac{1}{2}$ ft. |
| Branch supported by 3 props which rested on stone pedestals. | |
| Height of tree, including dead branch | 56 ft. |
| Diameter of cavity on ground | 9 ft. 10 in. |

Branch torn away by storm in 1722.

**1834.** LAUDER says the main branch was rent away by a storm in 1718.

**1842.** CHARLES EMPSON's measurements—

| | |
|---|---|
| Girth on ground | 60 ft. |
| ,, 1 ft. above ground | 56 ft. |
| ,, 3 ft. ,, | 45 ft. |
| ,, 4 ft. ,, | 38 ft. 6 in. |
| ,, 5 ft. ,, | 36 ft. 3 in. |
| ,, $8\frac{1}{2}$ ft. ,, and close under the great branch | 34 ft. 6 in. |
| Length of main branch | $50\frac{1}{2}$ ft. |
| Girth of ,, close to trunk | 10 ft. |
| ,, ,, 3 ft. from trunk | 8 ft. 4 in. |
| ,, ,, 9 ft. ,, | 6 ft. 9 in. |
| ,, ,, 17 ft. ,, | 5 ft. 3 in. |
| Height of tree, including dead wood | 43 ft. |
| ,, without ,, | 33 ft. |
| Length of second principal branch | 30 ft. |
| Girth ,, ,, 8 ft. from trunk | 5 ft. |
| Diameter of cavity on ground | 11 ft. |
| Average diameter 8 ft. above ground | 7 ft. 8 in. |
| ,, 12 ft. ,, | 7 ft. |

Soil—deep rich loam on fine clay.
Prof. Burnett's estimate of age, 1600 years.

**1853.** GRIGOR, in his "Arboriculture," says: "Cattle enter the cavity for shade and shelter;" hence it appears there were no palings round the tree then.

**1879.** Rev. THOMAS WHITE, Rector of Cowthorpe for thirty-five years, says: "I think the venerable tree has shrunk very much in my time."

**1883.** A cor. of "Notes and Queries" says: "The tree bears acorns."

| | |
|---|---|
| Girth on ground | 53 ft. |
| ,, 3 ft. above ground | $44\frac{1}{2}$ ft. |

**1888.** H. CROSSLEY, of Wetherby, says: "The consequence is that the tree has shrunk somewhat during recent years."

**1893.** JOHN CLAYTON's measurements—

| | |
|---|---|
| Girth on ground | 54 ft. 3 in. |
| ,, 3 ft. above ground | 44 ft. |
| ,, $5\frac{1}{4}$ ft. ,, | 36 ft. $10\frac{1}{2}$ in. |
| Length of main branch | $33\frac{1}{2}$ ft. |
| Girth of branch 2 ft. from bole | 9 ft. 9 in. |
| ,, 5 ft. ,, | 8 ft. 9 in. |
| Distance of underside of branch from the ground near the bole | 7 ft. 3 in. |
| Ditto 6 ft. away from the bole | 7 ft. 8 in. |
| Diameter of cavity on ground | 13 ft. × 9 ft. |
| ,, 2 ft. above ground | 11 ft. 1 in. × 8 ft. 7 in. |
| ,, 5 ft. ,, | $10\frac{1}{4}$ ft. × $7\frac{1}{2}$ ft. |
| Opening into cavity, west side on ground | 6 ft. wide. |
| Ditto 4 ft. above ground | $3\frac{1}{2}$ ft. wide. |
| Ditto 6 ft. ,, | 3 ft. wide. |
| Opening into cavity, south side, circular in shape, and 4 ft. diameter. | |
| Height of tree, including dead wood | 37 ft. |

The tree is supported by 25 props, disposed mostly on the south and east sides. There is a paling round the tree about 5 ft. high. It seems as if it had been put up from twenty to forty years ago.

A Cowthorpe man, named OATES, said: "The tree has shrunk very much in my time, and, in shrinking, the tree has twisted—the eastern branches towards the south."

There is to be seen a circle all round the tree 14 ft. away from the bole, showing that the soil was once thrown up about the bottom of the tree.

Age of the tree estimated to be about 500 years.

From an acorn borne by the celebrated old tree in 1893, a young plant has been reared and planted near its parent as a memorial.

In forest trees the work of death and decay is first seen at the extremities of the highest branches. These branches in a dying tree lose their leaves and twigs, and the tree becomes what is called stag-headed. This fact suggests that death in the roots commences in the extremities also, supposing the suggestion to be true, it is easy to understand why old trees shrink and settle into the ground (Photo. No. 5). The diagram is drawn on this supposition, and will illustrate what we mean.

Allow the figure under the year 1700 to represent the roots of the Cowthorpe Oak at that time, and assuming that the roots perish by decay at their extremities (as we know the branches do), then by 1842 their decay will have shortened them, probably to the dotted line anent that year, and will thus have made room for a general sinking or subsidence of the tree, the sinking of course being caused by the weight of the tree. The subsidence will also be gradual, according exactly with the progress of decay in the roots; and by 1893 their further decay will have shortened them again, say, to the second dotted line, and thus made room for a further subsidence.

It is impossible to prove a subsidence of trees in general as they grow old and decayed, because records are not made respecting their elevations. But the subsidence of the Greendale Oak, which has already been referred to, is beyond a doubt. The picture is a copy of a print of the Greendale Oak published in 1727, or three years after the roadway was cut through the tree. Along with the print is a statement that the archway was 10 ft. 2 in. high. In 1775 the height of the arch was measured again, and the former measurement was confirmed (Photo. No. 7),—this is given in Dr. Hunter's "Evelyn's Sylva" (Photo. No. 3). In 1894 the highest point in the arch was 9 ft. 3 in. from the ground. Thus this evidence shows a subsidence in the Greendale Oak

of 11 in., a fact which is important, for although there is ample independent evidence that the Cowthorpe Oak has sunk somewhat into the ground, yet it is more assuring to find that other trees do the same under similar conditions.

In 1879, the Rev. Thomas White, who had been Rector of Cowthorpe for thirty-five years, writes, "I think the venerable tree has shrunk very much in my time." In 1888, H. Crossley of Wetherby says, "The tree has shrunk somewhat during recent years." In 1893, a Cowthorpe man named Oates (sixty-seven years old) said, "The tree has shrunk very much in my time" (Photo. No. 5). In 1842, Empson gives a girth close under the great branch, which he stated was 8½ ft. from the ground, but this branch in 1893 was only 7 ft. 3 in. from the ground. These two measurements in fifty-one years show a subsidence of the tree during the time of 15 in. There is collateral evidence of the subsidence, furnished by the slanting position at the present time of the three props, which already supported the main branch in October 1829, for then they would be upright, and the difference between the upright position and the present slanting one shows a decrease in the elevation of the branch of 2 ft. There is another circumstance in connection with the Cowthorpe Oak which should be considered when comparing the earlier measurements with those of a later date. Sometime before Empson wrote (viz. 1842), the soil was dug up all round the tree at a distance of 13 or 14 ft. from the bole, and was thrown up about the bottom of the tree. By this operation the circumference of the tree where it meets the soil would be reduced, but certainly not so much as some writers would lead us to believe, for the trenching round the tree is evident to-day, and it was so little that one may see it could not affect the tree's dimensions as seriously as it has been asserted.

The explanations and proofs of the subsidence of the Cowthorpe Oak may be tedious, but they are important, as the phenomenon established thereby is common to forest trees. And without the explanations it would be impossible to reconcile the various measurements from the earliest time until now.

(Photo. No. 5.) The diagram shows the shape of the trunk of the tree, the diameter of which is greatest on the

ground and gradually gets less above. To be consistent with this shape, if we were to dig below the level of the ground the diameter would become greater still; but, instead of digging, suppose the tree were raised 15 in., or to the elevation it had in Empson's time, 1842—and Empson's measurement of the girth on the ground, 60 ft., appears quite credible and accurate, although it is certain the girth in 1893 was only 54 ft. 3 in.,—and suppose the tree were raised still further to make up for the subsidence between the dates of Dr. Hunter's measurements and Empson's, then Dr. Hunter's girth, 78 ft., would also appear credible. Thus the apparent discrepancies in the measurements of the girth of the tree on the ground are fully and reasonably explained. Other discrepancies in the measurements will be seen in the table, but none are serious, and most of them can be accounted for by the same reasons that have been employed in reconciling the measurements of the girth on the ground-level.

We are therefore prepared to receive Dr. Hunter's measurements as the dimensions of the tree before its decline, and if we can realise them properly we shall have a better idea of the former magnificence of the Cowthorpe Oak, and why it became so famous. Many people have seen the Major Oak at the Dukeries, near Edwinstowe. It is a wonderful tree, and is generally regarded as a sight worth seeing. But the Cowthorpe Oak was a much grander sight, as may be readily conceived by comparing a diagram of the two trees drawn to one scale. The Major Oak is 53 ft. high; the Cowthorpe Oak was 80 ft. high. From bough end to bough end of the Major Oak, it measures 94 ft. In this respect the Cowthorpe Oak measured about 120 ft. The Major Oak at 5 ft. from the ground girths 29½ ft.; at the same level the Cowthorpe Oak girths 36 ft. 10 in.

It is difficult to imagine a more suitable place for the largest development of a growing tree than the situation of the Cowthorpe Oak. The conformation of the locality, and its natural and artificial surroundings, would at all times make it a warm and sheltered spot. The tree is about the middle of a field which slopes gently towards the river—the river being near enough to afford a constant supply of moisture. At present there are other trees near it, but when it was young and in its prime, it

evidently stood somewhat alone—a condition favourable for the full attainment of its utmost magnitude. The soil where the oak stands is alluvial, and is both rich and deep.

If tradition may be trusted, it is nearly two hundred years since the first token of decline appeared in the Cowthorpe Oak. In November 1703, a terrible wind-storm swept over western Europe. In its violence it damaged the tree to a large extent; but it was another November storm, in 1718, that wrought the most injury, for by it the leading and central branch was torn away. It is also said that in 1722 the tree suffered much damage from another storm. After these disasters, the work of decay would doubtless proceed more rapidly, and now the work is so nearly accomplished that it seems impossible for the tree to survive much longer. However, what remains puts forth new shoots and leaves every season, though imperceptibly dwindling each year. In 1893 it bore a good crop of acorns, considering its ruined state. The acorns were not sessile, but were on long stalks. From some of them young plants have been reared, and, by permission of the late Mr. Montagu, of Ingmanthorpe, one has been planted, in the hope that it will perpetuate the memory of the doomed giant. The young oak is planted near its illustrious parent, and is securely fenced in. The Rector of Cowthorpe, the Rev. Mr. Clarke, has kindly undertaken to be the guardian of its youth.

Interesting as the Cowthorpe Oak is on account of its size, it is no less so when considered in relation to its age. Therefore we claim to be allowed to extract to the full the lesson which it teaches in this respect.

In the beginning of this century, the elder De Candolle promulgated the theory that trees never die of old age, and, barring the accidents of injury and disease, they would live for ever. Of course a doctrine so novel was not accepted at once, but before the century was half gone we find that it had taken strong hold in the scientific world, and among its adherents were Dr. Lindley and Dr. Asa Gray, both very eminent and learned botanists. The discovery of the Big-trees of California, and the indisputable testimony of their antiquity furnished by the annual

rings, seems to have completed the argument in favour of the theory. For since then the controversy has ceased. But the theory is so contrary to what is known of life that gradually it is beginning to be doubted, and now distinguished professors of forestry hesitate to commit themselves either for or against it.

We will quote Dr. Asa Gray's explanation of the theory:[1] "For the tree (unlike the animal) is gradually developed by the successive addition of new parts. It annually renews not only its buds and leaves, but its wood and its roots, everything, indeed, that is concerned in its life and growth. Thus, like the fabled Æson, being restored from the decrepitude of age to the bloom of youth, the most recent branchlets being placed by means of the latest layer of wood in favourable communication with the newly formed roots, and these extending at a corresponding rate into fresh soil, why has not the tree all the conditions of existence in the thousandth that it possessed in the hundredth or the tenth year of its age?

"The old and central part of the trunk may, indeed, decay, but this is of little moment so long as new layers are regularly formed at the circumference. The tree survives, and it is difficult to show that it is liable to death from old age, in any proper sense of the term."

It is clear De Candolle sincerely believed in his theory, for he worked continuously a number of years gathering evidence in its favour. The literature dealing with notable trees was at his command. This, along with his own observations, led him to believe that the oaks were among the veterans of Europe, but that of all species the yews attained the greatest age (of course it will be remembered he arrived at this judgment before the Sequoias or the Big-trees of California were discovered). From a number of sections of trees of various species, he assumed that he could determine an average growth by measuring the annual increment of each species. Thus he made the increase of the oak and yew on an average to be one-twelfth inch in diameter annually. And with this rate of increase, he computed the ages of three celebrated yews in

[1] Page 80, vol. 2, of "Gray's Essays," published by Macmillan & Co., London, 1889.

England, and one in Scotland. He reckoned the age of one of the yews near Fountains Abbey to be more than twelve centuries, taking a measurement of Pennant's as the basis of his computation. In this instance he confirms his reckoning by affirming that the tree was known in the year 1132—at the time when the foundations of the Abbey were laid. This statement is unreliable, and is due entirely to a passage in Burton's "Yorkshire Monasteries," bearing the comparatively recent date of 1757, where it is said—"We are told by tradition, the monks resided under these yews whilst they built the monastery." The yew at Crowhurst already mentioned, when speaking of John Evelyn, De Candolle estimated to be fourteen centuries old. The age of another yew at Braburn, in Kent, he estimated at three thousand years. And the yew at Fortingall, in Scotland, at twenty-five to twenty-six centuries. The irregularity which is apparent in the computed ages of these four yews is vastly augmented by the ages of yew trees in general, and De Candolle contends that such an irregularity is just what might be expected, and he regards the irregularity as confirmatory of the theory of the indefinite longevity of trees.

About 1830, or at the time when it seems the theory might be most generally accepted, Prof. Burnett assigned sixteen hundred years as the age of the Cowthorpe Oak. That Prof. Burnett made the assertion from a computation made according to De Candolle's theory there is no doubt, and his computation must have been based on some published measurement, for, as far as can be gathered, Prof. Burnett was never at Cowthorpe. Nevertheless Prof. Burnett's estimate of the age of the Cowthorpe Oak is commonly received, but as we believe it to be inaccurate and greatly exaggerated, we imply a want of faith in the basis of his computations; and this is so. We regard De Candolle's theory as altogether untrue, and not sustained by facts. In justification of these remarks, let us consider the photograph.

The picture (Photo. No. 6) represents a portion of the bole of an oak as it was laid in the timber yard of Messrs. Ackroyd, of Birkenshaw, in August 1894. It had been grown at Ravenfield, in an ancient park situated midway between

No. 1.—Trunk of Yew Tree at Crowhurst.
Girth—34 ft. 4 in., on the ground; at 3 ft. above, 32½ ft.; at 5 ft. above, 30 ft.

*Photo. taken August* 1895.

No. 2.—Trunk of Great Chestnut at Tortworth.

Girth—49 ft. 2 in. at 4 ft. above the ground (*i.e.* where the paper is fixed).

*Photo. taken September* 1894.

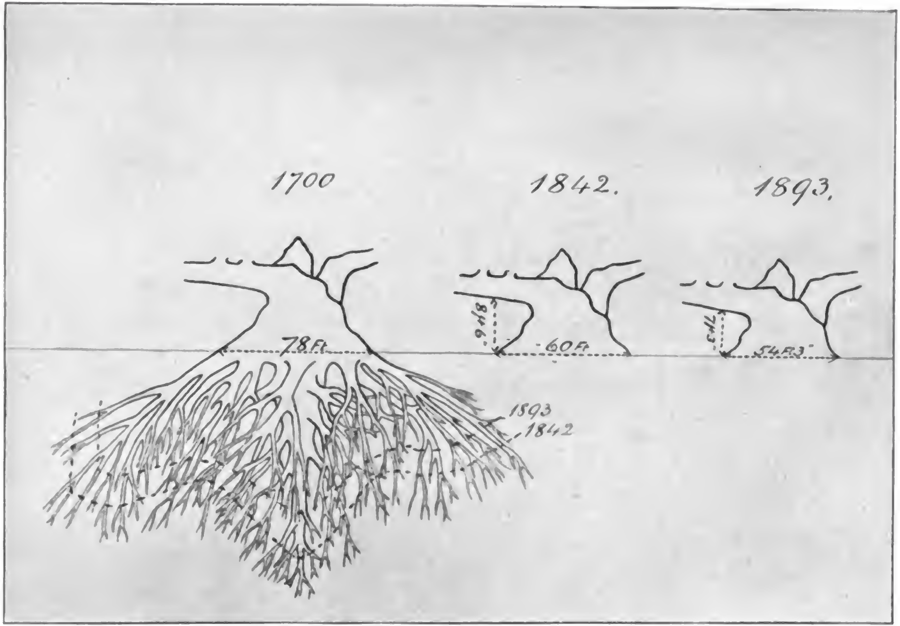
No. 3.—Trunk of Greendale Oak.

The roadway was cut through in 1724. Girth—30 ft. 1 in., at 4½ ft. above the ground.

*Photo. taken June 1894.*

No. 4.—Cowthorpe Oak, seen from North.

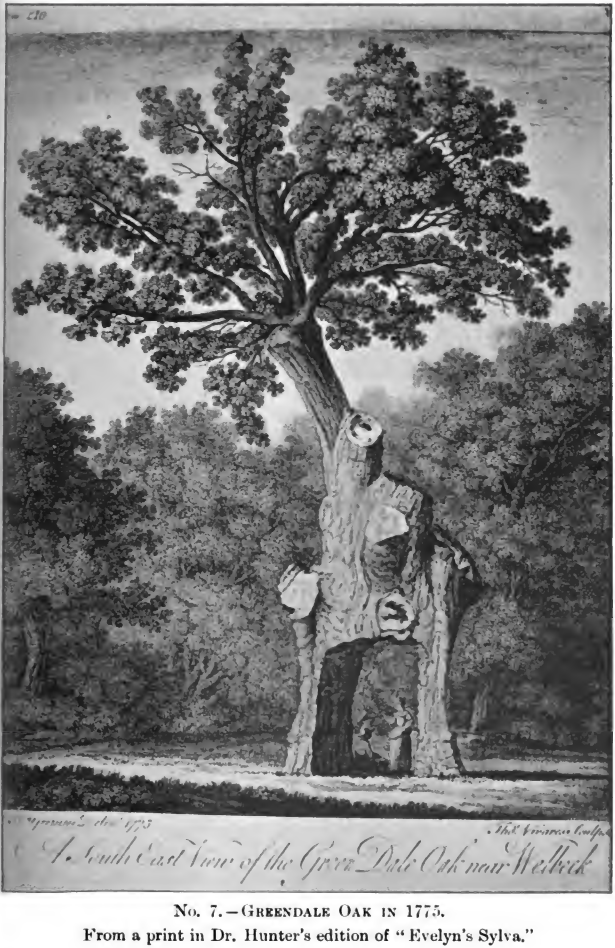
*Photo. taken April 1893.*




No. 5.

The diagram shows how the ground measurement of the Cowthorpe Oak would get less, as the decay of the roots allowed it to settle farther into the ground.

No. 6.—SECTION OF OAK TREE BOLE.
With a lens the Annual Rings may be seen in the picture.




No. 7.—Greendale Oak in 1775.
From a print in Dr. Hunter's edition of "Evelyn's Sylva."

Doncaster and Sheffield. The tree was felled in 1885, when it contained altogether 1000 cubic feet of marketable timber. Another portion of the bole (which was 18 ft. long, or the same length as the one represented) had been cut up and sold. Thus the bole originally was one straight piece 36 ft. long without a branch, and had an average diameter of about 5 ft., all sound and clean wood. Certainly it was the finest timber tree we ever saw. A cross section of this tree displayed admirably the annual rings, from the centre to the circumference, and thus afforded a splendid test of De Candolle's theory. From the heart to the circumference it measured 27¾ in., and if we compute the age of the tree according to De Candolle by allowing one-twelfth of an inch for each year's increase in diameter, the tree had been growing six hundred and sixty-six years, but really it was only two hundred and twelve years old, according to the testimony of the annual rings. The annual rings were not uncertain or confused, on the contrary they were clear and legible throughout, and furnished such evidence of the tree's age as would have convinced De Candolle himself.

If Prof. Burnett had seen the section whilst he was engaged in calculating the age of the Cowthorpe Oak, it is likely he would have taken the ratio of yearly increment from the section, and rejected that of De Candolle's theory. Had he done so, he would have made out the Cowthorpe Oak to be, not sixteen hundred years old, but only five hundred and forty-five years. We suppose his calculation would be something like this—at 5 ft. from the ground the Cowthorpe Oak girths about 36 ft. Divide this dimension by three, and roughly the diameter is found to be 12 ft. Half this is 6 ft., or 72 in., which would represent the radius. The radius of the section is about 28 in., in which are 212 annual rings. How many annual rings ought there to be in 72 in.—the radius of the Cowthorpe Oak? Answer 545.

But we cannot accept the age of the old tree from any calculation based on ratios, whether they be those of the section or of De Candolle, or of any other tree. For no two trees grow alike, and no one tree increases in the same ratio one year after another. And if a small section were

taken from the circumference of the Cowthorpe Oak itself, and the rings measured with a view of arriving at the annual increment of the tree throughout its life, this method would be quite as fallacious, for trees when they are young grow much faster than when they are old.

Whilst considering the photograph (No. 6) of the section, let us see whether it supports or opposes De Candolle's theory of indefinite longevity of trees. From the centre to No. 1 there are 100 annual rings of growth. From No. 1 to No. 2 there are 50 rings. From No. 2 to No. 3 there are 20 rings, and from No. 3 to the circumference there are 42 rings. That is, for one hundred and fifty years, or to No. 2, the tree had increased upon the whole in a uniform degree, but during the next twenty years the growth slowed down to less than half as much, and the last forty-two years of its existence it had slowed down still more, so that there was hardly any growth at all. This decadence in growth during the latter years is said to be only apparent, and not real. For, during the latter years, the tree is said to be so much bigger than what it was formerly, that though the annual layer of growth which covers the whole tree is thinner, the extended area of the surface of the enlarged tree is so much more as to account for the difference in the thickness of the annual growth. This explanation might be convincing in the absence of the photograph, but with the photograph before us it is not, for that plainly indicates that the thickness of the annual growth was nearly uniform to the time when the tree would be one hundred and fifty years old, notwithstanding that during all those years the surface of the tree would be annually enlarging. Therefore the lessening of the thickness of the annual growth in the latter years is distinctly different to what had happened during the one hundred and fifty years before, and it is a natural decadence which had come with years, that pointed as certainly to death from old age, as it flatly contradicted the theory of indefinite longevity of trees.

If we could have watched this tree during all the two hundred and twelve years of its life, we should have seen it grow in height and spread of branches till perhaps it was seventy to one hundred years of age. Then for fifty

years its appearance in these respects would not alter. The amount of foliage it would put forth each year would increase, for the twigs would have ceased as a whole from extending, and as they became effete towards their extremities, younger and more numerous twigs would push out somewhat lower down, and all would bear leaves. Thus we see the constant increase in the amount of foliage would be quite adequate to support an annual increment such as the section displays for one hundred and fifty years of its life. Then younger twigs would not so readily push forth, consequently the leaves would become fewer, and the annual increment, as shown by the section, would become less; and had not the tree been cut down this process would have gone on—increasingly so—till the top had become stag-headed and the bole of the tree hollow. Asa Gray, in his statement of De Candolle's theory, says: "The old and central part of the trunk of the tree may, indeed, decay, but this is of little moment, so long as new layers are regularly formed at the circumference. The tree survives, and it is difficult to show that it is liable to death from old age in any proper sense of the term." But to a tree, the becoming hollow is of great moment. The trunk is the only channel for the sap to pass from the roots to the head, and if the channel be narrowed by decay, less sap will pass, and there will be fewer leaves as a consequence, and the new layers formed at the circumference will become thinner. This process only needs to go on a while and the tree will no longer survive, and old age and its attendants will as surely bring about the death of the tree as they do that of other living organisms.

Having refuted De Candolle's theory, and shown how unreasonable Prof. Burnett's calculation is respecting the age of the Cowthorpe Oak, we now take upon ourselves the task of stating, not definitely, the age of the tree, but particulars of its history, during the hundred years that it has been known and recorded, with the hope that these particulars may help us to form an estimate of the age—within rather extended limits it is true, but probably as near as it is possible.

We have seen that in the life of a tree there is a period when it grows in all directions, and another period when

its general appearance—such as height and spread of limbs and foliage—remains almost unaltered, and a third period which is one of decay. The third period in the life of the Cowthorpe Oak we know almost perfectly, and the problem is, What was the duration of the other two periods? From evidence afforded by other trees, we think the time would not be much more than double the duration of the third period.

In Sherwood Forest and the neighbourhood there are some remarkable trees. At Studley the trees are finer still. But it is at Castle Howard that arboreous vegetation reaches nearest to perfection. There the natural conditions seem to be exceedingly suitable to the well-being of trees, and it is evident that the conditions have been aided for nearly two hundred years with all the ability at the command of man.

The work in connection with building of Castle Howard—the laying out of the grounds and the planting of trees—was commenced in 1702, and was finished in 1731. Thus the magnificent avenues there must be composed of trees about one hundred and eighty to two hundred years of age. The species which most abound are limes, beeches, and oaks. Their condition is that of a vigorous old age; they look well, but are certainly all on the decline. Here and there one has fallen as the consequence of premature decay and storms. In approaching the mansion, there is a number of large old oaks to be seen, 15 and 16 ft. in girth, all hollow and stag-headed. This circumstance is so peculiarly theirs, that one is bound to believe them to be the remains of a generation which flourished before that of the present plantation, and would be large and fully developed trees at the time Castle Howard was building, and similar in age and vigour to that of the later generation at the present time. Thus their decay has been accomplished in one hundred and fifty to two hundred years. The stage of decay at which these trees have arrived is about the same as that of the Cowthorpe Oak. Suppose, therefore, we take the two generations of oaks at Castle Howard as a criterion to ascertain the age that oaks will live to under favourable conditions, and we shall find the age to be three hundred and fifty to four hundred years.

With the knowledge that trees are not necessarily old if they have a large girth,—for trees with a large girth always grows faster than those with a less girth, and in proportion to the size they ultimately attain. Yet it seems absurd to ascribe four hundred years as the duration of the life of the Cowthorpe Oak, which for seventy years has been regarded nearly as old as the Christian era. However, all trustworthy evidence favours such a term, and if we incline to extend it to five hundred or six hundred years, it is more than the evidence warrants. Two hundred years since, the older generation of oaks at Castle Howard must have been fine trees, otherwise the fastidious founder of that place would have cut them down. Indeed, their condition would be like that of the Cowthorpe Oak, as it is nearly two hundred years since the first great branch was severed from it, and before that date its proportions were exceedingly grand, and no signs of decay had appeared. Since then the decline of the Cowthorpe Oak and the old oaks at Castle Howard has been about equal, and the circumstances of both are so parallel that whatever age is assigned to one must by all that is reasonable be assigned to the other.

The rapid progress of decay in the Cowthorpe Oak is another circumstance that points to a moderate duration of its life. Dr. Hunter's picture represents the tree in 1776. In 1893, scarcely one hundred and twenty years after the photograph, Photo. No. 4 represents the tree. If the tree was hollow in Dr. Hunter's time, it is not apparent in his print, nor does he speak of it in his letter-press description. Thomas Maude saw the tree in 1774, and he made a calculation showing the quantity of timber in it, supposing the trunk to be sound. Robert Marsham measured the tree in 1768, and he does not say anything about the tree being hollow. Hence if the tree was hollow one hundred and twenty years since, it could not be seen from the outside, otherwise one of these observers would certainly have seen it and mentioned it. In 1893 the diameter of the hollow on the ground was 13 ft. one way, and 9 ft. the other, and it had two entrances.

Perhaps there is nothing which shows so forcibly the rapid progress of decay as the contrast between Dr. Hunter's print

and the photographs of the ruined tree in 1893. And in presence of these pictures, which cover only a period of 120 years, the question may be asked, Does the age of the Cowthorpe Oak appear to be 400, 500, or 600 years? If we allow 400 years, then the tree was 280 years old at the time of Dr. Hunter's print, and since then it has been 120 years in coming to the present stage. If we allow 600 years, the tree was 480 years old at the date of Dr. Hunter's print. If 500 years be allowed (and it seems to us the utmost that can reasonably be assigned as the age of the Cowthorpe Oak), this would allow 120 years for the decay, and 380 years for growth and the partial declension which shows itself in Dr. Hunter's print.

Dr. Hunter's print is a faithful portrait of the tree in 1776, as is shown by another print, which depicts the tree about the same time, although it appears in the "Gentleman's Magazine" for 1831. Another picture of the old tree was sent to us by Mr. Carruthers, of the British Museum. It was published in 1806. In all the three engravings (Dr. Hunter's included) there is no sign of a cavity in the trunk; but in 1822, when J. G. Strutt was sketching the tree, the cavity was not only apparent, but could be entered in two places. Loudon, in 1829, says the floor of the cavity measures 9 ft. 10 in. across. Empson's picture, dated 1842, shows the opening to the hollow or cavity, and in his dimensions he states that at the base it measured 11 ft. across. In 1893 our measurement was 13 ft. This dimension and the photograph will show that the trunk was merely a shell.

Notwithstanding the careful and prolonged study of the Cowthorpe Oak, and the many efforts we have made to correct error respecting it, we have little hope that writers for popular papers will be influenced by them. Only six months since, a writer for a leading periodical who had had access to the results of our research, declared the tree to be sixteen hundred years old, and the print (date we believe is 1872) shows what an illustrated paper will do in exaggerating things, when it is compared with an actual photograph.

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# TRANSACTIONS AND PROCEEDINGS

OF THE

# BOTANICAL SOCIETY OF EDINBURGH

## SESSION LXVIII.

### A NEW WEST-AUSTRALIAN PLANT: DROSERA BULBIGENA, A. MORRISON. By ALEXANDER MORRISON, M.D.

(Read 12th November 1903.)

DROSERA BULBIGENA, *A. Morrison.* — Stem filiform terminating in a few-flowered raceme, rootstock forming a bulb; stem-leaves with a lunar-peltate lamina, those at base reduced to scales. Sepals ovate, with long cilia-like teeth, glabrous, half as long as petals. Styles in two, sometimes three, tufts of subacute filaments spreading from the base, or occasionally also dividing higher up into two or three branches.

Coolup, Murray River (R. Helms). Wet flats, Lower Canning River (A. Morrison).

Plant 3–6 cm. in height above ground, quite glabrous, with a rootstock of 4 cm. or less covered with pale brown fibrous remains of the old axis and sending out a few long horizontal processes close to the surface of the ground; at the base terminating in a bulb covered with thick dark brown scales, or forming a series of bulbs developed in succession downwards. Stem erect, slender, flexuose, its leaves on slender petioles of 2–3 mm. dilated at the base but without stipules, lamina truncate orbicular 2 mm. or less in diameter and reflexed on top of petiole which is

attached close to the truncate margin, one or two of the lowermost leaves reduced in size, and 1–3 lanceolate scales at the base. Raceme unilateral on a peduncle of 1 cm. or more above last leaf, pedicels somewhat longer than sepals which are 2–3 mm. including the teeth, ovate and glabrous; petals 4–6 mm. ovate or obovate, obtuse, white; filaments dilated at the top, anther-cells distinct. The flowers vary in number from 1–6 in the raceme, and are mostly 5-merous, but the styles are only 2–3 in tufts of 6–12 slightly tapering filaments. Irregularities have, however, been noted, as a male 4-merous flower; another hermaphrodite and 4-merous, but with 3 styles; and one 8-merous showing 8 petals, but with the seventh sepal a short way down the pedicel, and the eighth, like a bract, still lower, while the seventh and eighth stamens are connate, and the styles are in two main divisions, with numerous branches spreading from the base. The bracts are frequently absent and variable in size, lanceolate and more or less ciliate, or setaceous, sometimes in pairs.

The affinity of this plant is clearly with *Drosera Banksii*, R. Br., and *D. myriantha*, Planch., not only in the important character of the style-branches, which are fewer than in any other species of the cauline type of *Drosera*, but also in the general similarity of most of the other characters. These three species by themselves form, by reason of their less divided styles, a small group connecting the long-stemmed species of the *Ergaleium* section with those of section *Rorella*, in most of which the styles are simple or few-branched.

The presence of stipules to the upper leaves in *D. Banksii*, as described, is unknown in any of the cauline species of *Drosera*, and their description as such may have been due to an error of observation, not subject to correction up to the present time, as that species is not recorded as found by any collector since Banks and Solander. Bracts are not uncommon, although irregular on the inflorescence of some species, and they sometimes answer to the description of the stipules of *D. Banksii*, as thin, narrow, and scarious; so that between the upper stem-leaves and the flowers, some of these organs may have been observed and hastily noted as deciduous stipules.

## Note on the Formation of the Bulb in West-Australian Species of Drosera. By Alexander Morrison, M.D.

(Read 12th November 1903.)

The presence of more than one bulb on the root of *Drosera bulbigena*[1] suggested a closer examination of specimens, in order to determine their mode of formation, especially of the extra bulbs. The rootstock is seen to be covered with the pale brown fibrous remains of the rhachis of the previous year's plant,—the present axis being enveloped in it from the bulb to the surface of the ground. A moderate number of short horizontal roots, copiously provided with hairs, spring from the rootstock, penetrating this fibrous sheath, while from its upper part—close to the surface of the ground—proceed commonly one or more long out-runners smooth and apparently of the same structure as the rootstock itself, with occasionally a short lateral root provided with hairs. Such long processes, or stolons, are common on some Australian orchids, for instance some species of *Pterostylis,* in which they frequently end in bulbous swellings; but in this species of *Drosera* no distinct thickenings have so far been observed.

The majority of plants of *D. bulbigena* have only one bulb; but two, three, or even four such are met with—arranged in series, the one directly below the other. At about one inch below the surface the rootstock expands at its base into a short conical body, closely applied to the upper surface of the bulb, but continuous with it only by means of a slender and very short pedicel. The bulb itself is enveloped in thick dark brown scales, and is subglobular in form, flattened on the upper side, and somewhat pointed below. It appears to have been developed from the enlarged extremity of the rootstock—to which the name of *pro-bulb* may be given—by a process of budding from its lower surface. In the case of a plurality of bulbs, the same budding process has taken place in the formation of new bulbs,—each successive one being formed on the end of a prolongation of the axis

[1] See page 1.

from the base of the preceding bulb to a greater or less distance below. This process, which is quite like the old rootstock, is smooth, and pale in colour, and in dried specimens is sometimes seen to be loosely wrapped in a membranous covering, evidently an exfoliation. This downward extension of the plant's axis is an exact counterpart of the rootstock above it, terminating like it in the pro-bulb expansion, with the true bulb attached to its under surface. The close association of the two structures appears to exist from an early stage in their development, as shown in one plant in which the fourth bulb-formation on its axis is seen of very small size at the end of a process 2 mm. in length. In this case the one is about as large as the other, namely, 1 mm. in diameter,—although at a later stage the bulb will attain larger dimensions. The brown scales of the true bulb are quite distinct from the membrane of the rootstock, and appear to be an exfoliation from its substance of annual occurrence. As the downward budding process takes place during the flowering period, resulting in the formation of a reserve of nutriment for the plant during the immediately following dry season, so we may assume as highly probable that at an earlier period, when the winter rains followed the long dry summer, the base of the rootstock must send a shoot upwards to form the stem of the plant that makes its appearance above ground in the course of the winter. This pro-bulb, therefore, may be regarded as containing the dormant bud, or buds, from which the plant is annually renewed,—these being the homologues of those buds known as the winter buds or hybernacula in the axils of the rosette-leaves of European species of *Drosera*. It may be a nice point for consideration whether the pro-bulb or the bulb is the really permanent organ on which the plant depends for its annual regeneration. Unfortunately, direct observation of the earliest stages of the growth of the new axis of the plant is difficult of attainment, seeing that after the flowering season of the bulbous species of *Drosera* is over all that was visible of them above ground quickly disappears, and nothing to indicate their presence can be detected till the new stem appears above the surface in the following spring.

In *D. calycina* the same arrangement of parts is seen as in *D. bulbigena*, and on a larger scale,—the stock ending in the swollen pro-bulb capping the bulb itself, or continuing farther downwards through one or more successive bulbs. When the upper bulbs in a series are atrophied and shrivelled, it is not clear from what portion of the axis the new stem sent up in the spring took its origin; this would depend on whether the rootstock died down to the lowermost bulb, or retained its vitality for some distance above that point. As the rootstock between the bulbs of a series is sometimes seen enveloped in a loose membranous covering, it would appear as if the previous year's axis had perished, and that the existing one had sprung from a point below the upper bulb; and if further proof is required of the development of the bulbs taking place from above downwards, the existence of this sheath, which can only be the remains of a preceding rootstock, will supply it. The presence of a new stem taking an independent course through the soil to the surface is seldom or never seen, the direction taken being always exactly in the line of the old one, from whatever point it may have arisen. A second stem is, however, not unfrequently observed, in various species of *Drosera*, to spring from a node of the rootstock at different levels between the bulb and the surface of the ground, but only as a branch, though usually within the same sheath as the main axis.

A recent examination of fresh specimens of various species of *Drosera* confirms to a large degree the statements above made, the distinction between the tissues of the living plant and the remains of the growth of previous years, as well as the arrangement of the scales on bulb and rootstock, being much better seen.

In *D. stolonifera*, which is one of the forms having the leaves arranged in rosettes, the large bulb of a fresh specimen (with flowers partly expanded) was bisected, and on removing one half of it a bud was displayed projecting downwards into its substance from close to one side of the base of the rootstock. This bud was as yet no more than about one and a half lines long, and diverged slightly to one side, namely, inwards towards the axis of the plant.

No scales were detected on its basal portion, and no distinct bulb was differentiated on it at its termination, but a small circle of pointed scales was seen closely applied to and converging near the tip, which is visible beneath them smooth and rounded. In other more advanced specimens the form of the growing process is distinctly bulbous, and its enlargement is seen to have taken place almost entirely on the external aspect, as indicated by the scale-tips being few and distinct from one another, compared with those on its inner aspect. The direction of the scales is evidently downwards on the external surface, but through excessive growth of that part by an interstitial hypertrophy of the concrete bases of the scales, the direction of the free tips of these organs becomes gradually changed towards the distal end of the bud, so that as the bulb enlarges the terminal scales, though still holding the same position relative to the part to which they are attached, and the same direction relative to the apex of the bud, come to point upwards. The axis of the bud has thus been turned completely round, so that its apex instead of being the lowermost point of the young shoot, is now the uppermost point of the new bulb. The process gone through is similar to that seen in the development of the anatropous ovule, and the result is that the terminal scales of the bud springing from the rootstock now form the apical bud of the bulb, situated close to its point of origin, and immediately below the parent stock. Here, then, is evident provision for the next year's stem, and proof that the bulb is the dormant bud, which, though in its turn also perishing, continues the life of the plant from one season of activity to the next.

In *D. erythrorhiza* (its flowering season past) the same structural arrangements are seen, even more neatly defined. The bulb is more dense in its consistence, and deeply coloured to its centre, while the great number of thin scales in which it is closely wrapped shows that many years must have passed since the annual budding from the original rootstock first began. The lateral process or pedicel connecting it with the rootstock continues slender and rounded, and the globular bulb is somewhat flattened vertically, while the reversed scales are collected together

so as to form a small compact cone, erect by the side of the pedicel, with its apex closely applied to the centre of the base of the rootstock.

In young plants of *D. calycina*, with stem and leaves developed, but without flowers, the bulbs of last year are seen brown and shrivelled, while from the bottom of some a new axis of white living tissue has been sent straight down, in one instance for half an inch below the base of the bulb. From near the margin of the flat lower end of the rootstock, at this part copiously furnished with strong smooth roots, a stout process has been pushed through the bottom of the old bulb, which is now a mere husk, and continued downwards as a new axis, clavate like that from which it springs, and bearing attached to its lower truncate extremity a small globular body, the new bulb.[1] It bears on its surface a few acute scales like the old rootstock, but these point downwards, and no roots are present on the process. The young bulb at its end is quite globular, and though almost touching its peduncle, the constriction between the two passes completely round, leaving only a narrow connecting pedicel. A few scales are seen projecting from the very narrow sinus between, and in the light of what has been seen in *D. erythrorhiza* and *D. stolonifera*, a closer examination of the few specimens available shows that these are attached, not to the clavate peduncle on which the small bulb is borne, but to the bulb itself, and that other scales are present on one side of the bulb, few in number, but sufficient to show the passage from those directed downwards through the horizontal to the upward direction, as seen more distinctly in the larger bulbs of the rosette-forms. The upper shrivelled bulbs, when there is more than one present, are seen as a band or ferrule of wrinkled brown tissue encircling the white shaft of the rootstock, on which they are quite loose and movable. In another plant of this species a brown and dead bulb was found on being cut open to be a mere shell,

[1] This is not a rootstock, though similar in shape, differing as it does in origin and in function, and the term 'pro-bulb' would be more appropriately applied to it than, as first suggested, to the base of the rootstock bearing the stem. It is significant that, while the downward bud from the rootstock takes its origin laterally, the bulb itself keeps a central and permanent position in relation to the axis of the plant.

but concealing within it a small budding shoot, the tip of which just touched its lower end.

If we conceive the plant of *Drosera* as consisting essentially of an axis bearing numerous nodes which give origin to organs variously modified according to their position on the axis, we see in the cauline type a great elongation of the internodes, through which the true leaves are removed from the surface of the ground and distributed at wide intervals along the stem. This arrangement of the leaves is in strong contrast with that seen in the rosette-forms with bulbs in which the axis is so contracted that all the leaves lie spread out flat in close contact with the ground. It may be supposed to be advantageous to the plant to have its leaves exposed in this way, whether for the exercise of the ordinary functions of the leaf, or for the capture of insects; while a converse advantage is secured by the use of the leaves as prehensile organs, through which it adheres to the branches of other plants, supporting its weak stem by that means, as in *D. macrantha*, for example, which is sometimes to be seen rearing its raceme of large white flowers erect above shrubs several feet high. An advantage of even greater importance, in a climate subject annually to a long dry season, is gained in the extension of the root downwards, which gives to the plant additional security against drought. This is effected by an expansion of the internodes of the shoot sent down from the rootstock for the regeneration of the bulb, as described above, the short pedicel of the rosette-forms being extended into an organ that places the new bulb in a deeper position, where it will be less exposed to the chance of desiccation. The habit of prolonging the axis downwards in this way is mostly seen in the cauline type, but not exclusively so; while, on the other hand, in the climbing *D. macrantha*, the new bulb is formed separate from the old, and diverging at an angle, as is the case in the Orchideæ.

PRELIMINARY REPORT ON THE BOTANY OF CAPTAIN DOWDING'S COLOMBIAN EXPEDITION, 1898–99. By T. A. SPRAGUE, B.Sc. (Edin.), F.L.S., Assistant in the Herbarium, Royal Botanic Gardens, Kew.

(Read 14th January 1904.)

In the summer of 1898 I heard, through Professor Bayley Balfour, that Captain (now Rear-Admiral) H. W. Dowding, R.N., was contemplating an expedition to the South of the Republic of Colombia, and that he desired to be accompanied by a botanist, as part of the country to be visited was botanically unexplored. On Professor Balfour's advice, I made arrangements to join the expedition, and, after a short time spent at Kew and the British Museum (Nat. Hist.), gathering information on the vegetation and flora of Colombia, left England in October 1898 in company with Captain Dowding.

Our route was briefly this:—up the Orinoco and its tributary the Meta to the village of Cabuyaro, then by mule across the *llanos* and the Cordilleras to Bogotá, thence *viâ* Jirardot along the Magdalena valley to Pitalito in the South of the Department of Tolima, and finally across the Eastern Cordilleras to the village of Mocoa, the capital of the Caquetá territory; here we separated, Captain Dowding returning to England in consequence of ill-health, *viâ* Pasto, Tumaco, and Panamá, while I descended the rivers Putumayo, Aguarico, and Napo to the Amazon, arriving in England in December 1899.

The task of determining my collection, in itself laborious owing to the scattered state of the "literature" on Colombian plants, and to the poverty in Colombian material of the two great British Herbaria, has been undertaken in the intervals between other official work, and has sometimes been suspended for months together. Up to the present date (December 1903), only the *Polypetalæ* have been completely worked out, and as the determination of the collection will probably not be completed for some considerable time, it has been decided, with the permission of the Director of the Royal Botanic Gardens, Kew, to publish at once the following diagnoses of new

species; the majority of the specimens described were collected by myself during the expedition, but a few of them are allied species, previously represented in the Kew Herbarium, and in these cases the collector's name is given. Descriptions of two new American Bignoniaceæ are appended. The enumeration of species collected, with their geographical distribution, etc., and a discussion of the general results attained, is reserved for a subsequent paper.

I desire to record here my indebtedness to the Royal Society for a grant of £50 towards my expenses on the expedition, and to Professor Chodat for the description of *Securidaca amazonica*; my thanks are also due to Mr. Hemsley and all my colleagues, and more especially to Dr. Stapf, for much kindly assistance and advice on critical points.

## DILLENIACEÆ.

*Saurauja pulchra:* ramuli crassi superne nigri ut petioli tuberculati; lamina obovato-oblonga, apice rotundata vel cuspidata, 12–19 cm. longa, margine tenuiter dentato-serrulata, venis lateralibus utrinque 20–22, tertiariis irregularibus; pagina superior nitidula glabra, inferior minute pulverulenta; paniculæ crassæ paucifloræ; flores 2·5 cm. diam.; sepala extra pulverulenta; stamina circa 42; styli minimi.

San Agustín, Tolima, No. 323.

*Saurauja æquatoriensis:* ramuli superne nigri ut petioli strigoso-setosi; lamina obovato-oblanceolata, apice breviter acuminata, 10·5–14 cm. longa, margine serrulata, venis lateralibus utrinque 16–17, tertiariis irregularibus; pagina superior nitidula glabra, inferior inconspicue pulverulenta, venis setosis; paniculæ graciles plurifloræ; flores 1·3 cm. diam.; sepala extra strigulosa; stamina circa 35.

Baños, Ecuador, *Spruce*, 4989.

*Saurauja floribunda, Benth. MS. in Herb. Kew.:* ramuli fusci internodiis elongatis; petioli strigulosi pulverulenti; lamina oblanceolata, apice obtusa interdum brevissime acuminata, 28–37 cm. longa, margine minute denseque denticulata, venis lateralibus utrinque 19–23, tertiariis irregularibus; pagina superior scabriuscula, inferior pulveru-

lenta; paniculæ floribundæ longepedunculatæ; flores 1·25 cm. diam.; sepala utrinque dense pubescentia; stamina 42–44.

Pallatanga, Ecuador, *Spruce*, 5540.

*Saurauja Sprucei:* petioli dense pulverulenti; lamina obovato-oblonga, apice abrupte acuminata, 25·5–30 cm. longa, margine denticulata, venis lateralibus utrinque 28–30 patulis, tertiariis regularibus; pagina superior scabriuscula, inferior pulverulenta; paniculæ pluriflorae; flores 2·25 cm. diam.; sepala extra pulverulenta, intus pubescentia; stamina ultra 150; styli minimi.

Chimborazo, Ecuador, *Spruce*, 6195.

*Saurauja Schlimii:* ramuli fusci ut petioli longe ferrugineo-setosi; lamina obovata, apice breviter acuminata, 16–20 cm. longa, margine setuloso-serrulata, venis lateralibus utrinque 17–21, tertiariis satis regularibus; pagina superior minute tuberculata, inferior pulverulenta, venis setulosis; paniculæ pauciflorae; sepala extra dense pubescentia; stamina circa 40; styli longi, stigmatibus majusculis.

Sierra Nevada de Santa Marta, *Schlim*, 789.

## FLACOURTIACEÆ.

*Casearia camporum:* a *C. fockeana*, Miq., foliis brevioribus abrupte acuminatis, floribus minoribus staminodiisque crassis differt; ramuli purpureo-fusci, novelli puberuli; petioli breves; lamina oblonga vel elliptico-oblonga, 6–8·5 cm. longa, venis lateralibus utrinque 6–7, supra nitidula glabrescens, subtus præsertim venis prominentibus puberula; umbellæ 20–35-floræ; calycis lobi oblongi apice rotundati, 4·5 mm. longi, tomentelli, anthesi patentes; connectivum apice pilis paucis satis longis ornatum; staminodia clavata 1·25 mm. longa; ovarium pilosum, haud tuberculatum.

Cabuyaro, Rio Meta, No. 167.

## POLYGALACEÆ.

*Securidaca amazonica, Chod.:* rami brevissime pubescentes vel velutini, regulariter et divaricate ramosi, apicem versus subcurvati; folia herbacea vel chartacea elliptica vel ovato-elliptica subobtusa subtus et superne pubescentia vel

brevissime tomentosa, petiolo brevi tomentoso; lamina 60×30, 45 × 33, 45 × 26, 50 × 22 mm.; racemi axillares vel terminales, rhachi arcuata breviter tomentosa elongata (10 cm.) laxe denticulata; flores pedicellati haud conferti 10 mm. longi; alæ glabrescentes breviter unguiculatæ nervis pluribus repetite dichotomis subliberis; petala superiora quam carina breviora apice parum dilatata subretusa late linearia reduplicata ciliata; carinæ limbus cucullatus longior quam latus; crista conspicua flabelliformis plicata; ovarium gibbosum antice et postice pilosum; stylus basi tenuis medio vittæformis et dilatatus adscendens S-formiter curvatus, apicem versus haud latescens sed angustior; samara breviter gibbosa ala tenui acie ventrali erecta dein sensim curvata, dorsali regulariter descendente, inde inæqualiter oblongo-obovata glabra.

San José, Rio Putumayo.

## HYPERICACEÆ.

*Vismia floribunda:* a *V. cayennensi*, Pers., sepalis fructu patentibus, petalis eglandulosis staminibusque glabris recedit; arbor parva glaberrima habitu *V. cayennensis*; lamina pergamentacea; cymæ floribundæ; sepala ovato-oblonga fructu patentia; petala mucronulata, eglandulosa, facie interna villosa; staminodia breviter clavata, apice villosa; staminum phalanges polyandræ (25–30), podio apice excepto glaberrimo, filamentis specialibus glabris; antheræ glandula unica. Mocoa, Caquetá territory, No. 401.

*Vismia Sprucei:* species inter *V. cayennensem* et *V. floribundam* intermedia; arbor 30-pedalis; lamina tenuiter coriacea, nervo medio venisque subtus quam in *V. floribunda* magis prominentibus; cymæ floribundæ; sepala oblonga, fructu reflexa; petala sparse glandulosa, facie interna dense villosa; staminodia subquadrangularia recta, apice villosa; staminum phalanges polyandræ (35–40), podio parte inferiore glabro, apice ut filamenta specialia villoso; antheræ glandulis duabus approximatis.

Panure, Rio Uaupes, Brazil, *Spruce*, 2601.

## BOMBACEÆ.

*Matisia Dowdingii:* arbor alta, cortice griseo rugoso; lamina oblongo-lanceolata, basi cuneata, apice acutiuscule

acuminata, 22–27 cm. longa, membranacea discolor 3-plinervis, supra glabra, subtus stellatim pubescens; pedicelli solitarii ut calyces vivide castaneo-velutini; calyx campanulatus, basi attenuatus, 3 cm. longus; petala extra tomentella, intus basi glabra, ceterum sericea; tubus stamineus curvatus, intus glaber, cruris liberis stylum paullo superantibus; ovarium dense pilosum.

Mocoa, Caquetá territory, No. 370

STERCULIACEÆ.

*Sterculia colombiana:* a *S. rugosa*, R.Br., foliis brevioribus ellipticis subtus pilis minoribus numerosioribus vestitis differt; arbor excelsa, ramulis rugosis cinereis; petioli puberuli, supra applanati; lamina elliptica apice obtusa vel retusa, basi cordata, 13–19 cm. longa, 5–7-nervis, supra glabra, subtus stellatim incana, validissime reticulata; paniculæ 9–12 apicibus ramulorum congestæ, multifloræ, tomentellæ; *fl. masc.:* calycis laciniæ lanceolatæ medio appendiculatæ; columna staminea curvata basi papillosa, antheris sessilibus; fl. fem. fructusque desiderantur

San José, Rio Putumayo, No. 618.

MALPIGHIACEÆ.

*Tetrapteris tolimensis:* rami novelli ferrugineo-tomentelli, demum glabrescentes; lamina ovato-oblonga vel oblonga, basi rotundata apice obtusa interdum cuspidata, 8–10·5 cm. longa, venis lateralibus utrinque 6–7 subtus prominentibus pubescentibus; inflorescentia tota ferrugineo-tomentella, foliis floralibus majusculis; umbellæ 3–4-floræ in paniculam pyramidalem dispositæ; pedicelli crassiusculi, supra medium bracteolati; calyx 8-glandulosus; petala glabra, lamina oblonga auriculata, ungue crasso; filamenta inferiorem supra trientem antheræ inserta; ovarium pilosum, stigmate semiuncato; samara anisoptera, alis lateralibus basi distinctis, crista dorsali alata.

San Agustín, Tolima, No. 271.

OXALIDACEÆ.

*Oxalis insignis:* ab *O. hedysaroidi*, H.B.K., bracteis ciliatis, pedicellis brevioribus et filamentorum majorum pilositate recedit; herba 3-pedalis; petiolus communis 5–12·5 cm. longus; foliola ovata, basi acutiuscula, apice

emarginata, subtus glaucescentia, terminale 3–6 cm. longum; bracteæ lanceolatæ, sparse ciliatæ; pedicelli filiformes 3–4 mm. longi; filamenta majora parte libera dense pilosa, minora glabra; ovarium stipitatum, stylis pilosis; capsula sepalis sesquilongior; semina in loculis solitaria.

Pitalito, Tolima, No. 232.

## ANACARDIACEÆ.

*Tapirira pilosa*: a *T. myriantha*, Triana et Planch., foliis subtus dense pilosis venulisque supra impressis recedit; arbor 40-pedalis, foliis imparipinnatis 3–5-jugis; lamina oblonga utrinque angustata, apice breviter obtuseque acuminata, 10–19 cm. longa, supra glabrescens fusca venulis impressis, subtus dense pilosa; paniculæ foliolorum par infimum vix attingentes; *fl. fem.*: petala late ovata, rotundata vel emarginata, staminibus effetis longiora; discus crenulatus; ovarium dense flavo-pilosum; fl. masc. baccæque desiderantur.

San José, Rio Putumayo, No. 616.

## PAPILIONACEÆ.

*Galactia camporum*: a *G. jussiæana*, Kunth, proxima habitu erecto, calyce basi attenuato vexilloque obtuso recedit; suffrutex erectus, basi 2–3-ramosus; foliolorum lamina oblongo-elliptica, basi emarginata, apice obtusa mucronulata, supra pubescens nitidula, subtus reticulata dense pubescens; calycis pilosi laciniæ laterales tubo paullo longiores; corolla glabra, vexilli obovati obtusi apice ciliato excepto; alæ oblongæ; legumina subrecta, dense pubescentia.

Cabuyaro, Rio Meta, No. 166.

## MIMOSACEÆ.

*Inga olivacea*: ab *I. nobili*, Willd., affini bracteis propriis florum spathulatis corollaque quam calyx plus duplo longiore recedit; rami novelli subangulati, ut pedunculi ferrugineo-tomentelli, glabrescentes; folia 3-juga; petiolus haud alatus, glandulis profunde excavatis; lamina elliptico-oblonga abrupte acuminata, basi cuneata, 14·5–20 cm. longa, supra glabra, subtus sparse puberula; spicæ breves semiorbiculares; florum bracteæ propriæ spathulatæ persistentes; calyx

adpresse pubescens dentibus minimis; corolla sericea lobis lanceolatis.

Between Villavicencio and Bogotá.

*Inga gracilior:* ab *I. leptoloba*, Schlecht., bracteis propriis spathulato-oblongis corollæque lobis brevioribus recedit; arbor 15–20-pedalis, ramulis pallidis leviter costatis; folia 3-juga, petiolis haud alatis, basi incrassatis; lamina elliptica vel oblongo-elliptica, basi cuneata, apice acuminata, 13–17 cm. longa; spicæ breves densæ; bracteæ propriæ spathulato-oblongæ, extra pilosæ; calyx anguste tubulosus 4 mm. longus; corolla gracilis circa 8·5 mm. longa, lobis 1·5 mm. longis, tenuiter sericea.

Mocoa, Caquetá territory, No. 365.

LECYTHIDACEÆ.

*Lecythis prœalta:* ab *L. elliptica*, H.B.K., affini inflorescentiæ rhachide flexuoso lenticelloso nervisque lateralibus numerosioribus recedit; arbor vasta cortice cinereo; lamina elliptica, basi rotundata, apice rotundata retusa vel breviter acuminata, tenuiter reticulata, venis lateralibus majoribus utrinque 18–22, minoribus parallelis interjectis; inflorescentia circa 20 cm. longa, ramis satis patentibus; ovarium semi-inferum 4-loculare vel inconspicue 8-loculare, ovulis loculorum basi erectis.

San José, Rio Putumayo.

MELASTOMATACEÆ.

*Rhynchanthera orinocensis:* (§ *Anisostemones*) caulis longe glanduloso-pilosus; folia breviter petiolata, anguste ovata, breviter acuminata, basi rotundata, 4·5–5·5 cm. longa, margine ciliato-serrulata, utrinque adpresse pilosa, 7–9-nervia; rami floriferi laterales 3–4-flori; calycis lobi tubum æquantes; petala obovata, apicem versus ciliata; antheræ rostrum gracile elongatum antice inflexum; capsula ovoidea.

Caicara, Orinoco.

*Meriania hexamera:* a *M. splendente*, Triana, affini lamina basi cuneata petiolisque brevibus recedit; arbor ramulis tetragonis, junioribus compressis; petiolus 2–2·5 cm. longus; lamina obovata, breviter acuminata, basi cuneata, 7–14·5 cm. longa, 5-nervis, subtus venis minute furfuraceis, ceterum

glabra; paniculæ cymosæ terminales; calyx breviter campanulatus, undulato-lobatus; petala 6 obovata; stamina 12; ovarium 6-loculare.

Between Pitalito and Mocoa, No. 344.

*Leandra caquetana:* ab *L. dichotoma*, Cogn., affini calyce glanduloso-setuloso petalisque brevioribus recedit; ramuli petioli pedunculique setulosi; lamina late ovata, breviter acuminata, 4–5·5 cm. longa, membranacea, supra setulosa, subtus venis exceptis glabriuscula; paniculæ 4–6 cm. longæ; calyx dense glanduloso-setulosus, dentibus exterioribus subulatis; petala oblongo-lanceolata, obtusiuscula; ovarium 5-loculare, apice brevissime glanduloso-setulosum.

Mocoa, Caquetá territory, No. 409.

*Miconia perplexans:* a *M. polyandra*, Gardn., affini staminibus 10 antherisque auriculatis recedit; arbor ramulis petiolis inflorescentiaque dense stellato-furfuraceis; lamina lanceolata, breviter acuminata, basi attenuata, 7–12 cm. longa, 3-nervis, discolor, supra glabra, subtus stellatim puberula; panicula angusta compacta; calycis lobi deltoidei; petala oblique obovata, leviter retusa; stamina 10, connectivo basi postice auriculato; ovarium usque ad medium liberum.

Cabuyaro, Rio Meta, No. 31.

*Miconia acutipetala:* (§ *Eumiconia*) arbor parva, ramulis pallidis, novellis ut petioli setulosis; jugi folia inæqualia, lamina ovata, breviter acuminata, basi anguste truncata, 4–8·5 cm. longa, obscure crenulato-ciliata, 5-plinervis, membranacea, utrinque sparse setulosa; paniculæ terminales axillaresque pedunculis gracilibus additis 4–5 cm. longæ; calyx truncatus, 2 mm. longus, basi stellatim pilosus, denticulis subulatis; petala lanceolata acuta 5-nervia; antheræ 1-porosæ, connectivo postice calcarato, antice auriculato; ovarium 2-loculare, loculis 1-ovulatis.

San José, Rio Putumayo.

*Tococa caquetana:* (§ *Hypophysca*) a *T. parviflora*, Spruce, affini calyce stellatim tomentello petalisque oblique obovatis recedit; caulis foliaque *T. parviflora*; paniculæ 4–5 cm. longæ; calycis tubus cylindricus stellatim tomentellus, superne setulosus, dentibus interioribus rotundatis, exterioribus brevibus subulatis; petala 5, oblique obovata;

stamina 10, antheris 2 mm. longis; ovarium 3–4-loculare, apice minute puberulum.

San José, Rio Putumayo, No. 604.

## CUCURBITACEÆ.

*Gurania pedata:* a *G. coccinea*, Cogn., affini foliis pedatis calycisque dentibus angustioribus recedit; petiolus 5–10 cm. longus, sparse longeque pilosus; foliola elliptico-ovata vel oblanceolata, acute acuminata, margine ciliata, remote spinuloso-denticulata, utrinque glabra, terminale apice trifidum vel trilobum, 10–17 cm. longum; pedunculus folio suo paullo brevior vel æquilongus, gracillimus; calyx sparse pilosus, tubo ovoideo dentes subulatos æquante; petala breviter lanceolata: antheræ iis *G. coccineæ* similes.

Mocoa, Caquetá territory, No. 393.

## BEGONIACEÆ.

*Begonia andreana:* herba 2-pedalis, caule erecto; folia petiolata, ovato-oblonga, acuta, glabra, penninervia; inflorescentia multiflora 25–30 cm. diam., pedunculis pluries dichotomis; *fl. masc.:* sepala 2 suborbicularia; petala 2 anguste obovata; filamenta libera, toro convexo inserta, antheris duplo vel sesqui-longiora, connectivo ultra loculos producto; *fl. fem.:* lobi 5 ovati vel ovato-oblongi; styli 3 trifidi, ramis iterum bifidis, supra spiraliter evolutis; fructus ala maxima subtriangulari, margine superiore horizontali recto 1·75 cm. longo, inferiore curvato, duabus ceteris multo minoribus.

Villavicencio, Colombia, No. 133.

## RUBIACEÆ.

*Sipanea acinifolia, Spruce, MS. in Herb. Kew.:* ab *S. pratensi*, Aubl., calycis laciniis ovario vix duplo longioribus, glandulis duabus interpositis, recedit: herbacea caulibus decumbentibus, lateralibus floriferis erectis; internodia 3 cm. haud attingentia; folia mediocriter petiolata ovata vel oblongo-ovata, 7–16 mm. longa, utrinque setulosa; inflorescentia terminalis, 1–3-flora; ovarium dense setulosum, 1·5–2 mm. longum; calyx 3 mm. longus, laciniis lineari-subulatis; corollæ tubus extra sparsissime pilosus; antheræ apicem tubi subattingentes.

Orinoco: Caicara, *Sprague*, No. 383; Maypures, *Spruce*, No. 3562. Also from the Lower Amazons.

*Isertia alba:* ab *I. hypoleuca*, Benth., proxima foliis subtus manifeste reticulatis corollæque albæ indumento recedit; arbor 40 pedes attingens; folia obovata, breviter acuminata, basi cuneata, supra glabra, subtus dense sordideque incana, manifeste reticulata; calycis tubus truncatus integer, infra apicem leviter constrictus; corolla alba, extra pubescens, sinu basi haud tumido, lobis contortis anthesi reflexis.

Eastern Cordilleras between Pitalito and Mocoa.

*Isertia Purdiei:* *I. coccineæ*, Vahl, habitu accedens, differt autem calyce truncato, foliisque subtus incanis; folia elliptico-oblonga, caudato-acuminata, basi leviter cuneata, supra glabra, subtus sordide incana manifeste reticulata; calyx truncatus integer, haud constrictus, appresse pubescens; corollæ tubus extra sericeus, lobi spathulati, quam tubi tertia pars longiores, extra verruculosi, anthesi reflexi; antheræ 7 mm. longæ.

Muso, Colombia, *Purdie.*

*Sabicea camporum:* inflorescentia sessili habituque erecto ad *S. canam*, Hook. f., accedit, sed calyce hirsuto (in *S. cana* flocculoso) prima visu distinguitur; frutex erectus 1–1½-pedalis, basi 2–3-ramosus; folia oblongo-obovata, obtusa, breviter petiolata, supra scabra, subtus venis pubescentibus ceterum coacto-tomentella; inflorescentiæ sessiles axillares congestæ; calyx ovarium plus duplo superans, lobis lanceolatis, denticulo glanduloso interposito; corollæ tubus 4·5 mm. longus, extra hirsutus, intra fauce villosus, lobi 2 mm. longi; antheræ 1·5 mm. infra incisuras insertæ.

Cabuyaro, Rio Meta, No. 43.

## BIGNONIACEÆ.

*Anemopægma grandiflorum:* ex affinitate *A. Karstenii*, Bur. et K. Schum., a quo differt ovulorum seriebus 6 pro loculo, floribus foliisque majoribus; frutex scandens ramis præter nodos glabris teretibus, striatis; folia conjugata cirrho terminali trifurcato clausa, petiolo subtetragono supra breviter piloso 1·5–2 cm. longo, petiolulis supra pilosis 5–8 mm. longis, lamina foliolorum elliptica vel oblongo-

elliptica breviter acuminata obtusa, 10–12 cm. longa, 4·5–6 cm. lata, utrinque dense minuteque punctata, herbacea, subconcolore, nervis lateralibus utrinque 6–7; phyllæ stipulas simulantes rhomboideo-ovatæ obtusæ, subsessiles glabræ, 1–2 cm. longæ, 8–17 mm. latæ; cymæ axillares paucifloræ; bracteæ subulatæ 3 mm. longæ; pedicelli 7–8 mm. longi; calyx campanulatus truncatus, ope microscopii lepidotus, glandulis patelliformibus instructus, margine sparse breviterque ciliatus, 8–10 mm. longus, intus lepidibus densius obtectus; corolla tota 6·75–8 cm. longa, tubo recto 2·5–2·75 cm. longo, dein campanulato-infundibuliformis, lobis 1·5–1·75 cm. longis, basi 11–12 mm. latis, intus papillosis, extra glabra, intus infra staminum insertionem pilosa; stamina 3 cm. supra corollæ basin affixa, majora 3·25 cm., minora 2·5 cm., theca 5 mm., staminodium 7 mm. longum; discus pulvinatus 2·25–2·5 mm. altus; ovarium basi angustatum, leviter striatum, lepidibus minutis densissime obtectum, 4–4·5 mm. longum (parte inferiore ovulifera elliptica 2·5 mm. longa, parte superiore oblonga); stylus 6–6·5 cm. longus, basi incrassatus; stigmatis laminæ ellipticæ rotundatæ; ovula pro loculo 6-seriata, serie quaque 6–7-ovulata; capsule elliptica, stipite quam calyx breviore, valvis coriaceis nitidis 8 cm. longis; semina (juventute) ala opaca suberosa, 2·5 cm. lata, 1·5–1·75 cm. longa.

Trinidad: Botanic Gardens Herbarium, No. 6812.

*Tecoma Hassleri*: ab affini *T. ochracea*, Cham., calycis tomento facillime detergibili, foliolisque subtus arachnoideo-tomentosis recedit; arbor 5–8 m. alta, ·3–·4 m. diametro, ramis validis, novellis ipsis (præter nodos tomentosos) glabris, tetragonis, vetustioribus subteretibus, nigropunctatis; folia digitato-quinata (vel trifoliolata), petiolis 4·5–7·5 cm. longis, supra superne sulcatis inferne applanatis, ± tomentosis; petioluli laterales subnulli, medii 1–3 cm., terminales 2·5–4·5 cm. longi; lamina obovato-oblonga, 6–10·5 cm. longa, 3–6·5 cm. lata, obtusa, apice rotundata vel breviter acuminata, basi rotundata, apicem versus serrato-dentata, supra scabra dense lepidota, subtus inter venulas arachnoideo-tomentosa; flores in racemum congestum dispositi; pedicelli 4–7 mm. longi, dense tomentosi; calyx

tubuloso-campanulatus quinquedentatus, 15–17 (12–30) mm. longus, extra tomento aureo facillime detergibili, post delapsum tomenti niger, intus glaber, dentibus rotundatis mucronatis densius vestitis; corolla infundibuliformis, 6–6·5 cm. longa, lobis 1·5 cm. longis extra pilosis, lutea, parte anteriore intus densissime villosa; stamina 7–8 mm. supra basin inserta; filamenta minora 16–18 mm., majora 23–25 mm. longa; staminodium 7 mm.; thecæ 3–3·5 mm.; ovarium glabrum 4–4·5 mm. longum; stylus 26–27 mm.; discus vix 1 mm. altus.

In campo prope San Estanislao, *Hassler*, 4159, 4164.

## ON A BOTANICAL VISIT TO THE BALEARIC ISLANDS IN APRIL 1903. By JAMES W. WHITE, F.L.S., President of the Bristol and District Pharmaceutical Association. Communicated by ALEX. SOMERVILLE, B.Sc., F.L.S. (With Specimens in Illustration.)

(Read 10th December 1903.)

Many good things come to him who pursues a hobby. I do not say to him who *possesses* a hobby, for my own is to me a bright attraction ever in sight but always ahead of me, pleasantly and irresistibly luring me on to a pursuit that can never end in possession, because there can be no finality in the work that the pursuit entails.

Delightful experiences lie thickly by the track along which the field-botanist is beckoned; and among them, journeys to foreign lands in search of plants are perhaps the richest in charm and suggestion. Pictures of bygone rambles rise radiant in the memory as one turns over the herbarium sheets, and such visions not only awaken and recall many happy scenes, but stimulate to new effort and research. Probably no trip will more delight and soothe my fancy in after hours than that which has inspired the present paper.

The date was Monday the 20th of April, in the Easter vacation, and as my fellow-traveller's engagements made it necessary for him to be again in England on the 8th of May, there resulted eighteen days for a couple of botanists interested in the European flora to use to the best advan-

tage. Now, if one wants to gather plants at that early period, it is before all things essential that one should go as far south as possible. And a careful comparison of maps and time-tables showed that we could certainly have a day or so longer in the Balearic Islands than in any other spot on the same parallel of latitude. Sicily we intensely desired, and Corsica we greatly longed to see, but the first was too far away, and from the second the return steamers did not fit in. We learnt also, on turning to the books, that we should certainly find in the Balearics a very remarkable and interesting vegetation, richer in extent and in quality than that possessed by any other European district of similar size. Taking the relative areas of Corsica and Sardinia combined, of Sicily, and of the Balearic Isles, it has been estimated that while the first contains 1 endemic species in 933 sq. kilometres, and the second 1 in 336, the Balearics possess 1 in 95. This group of islands taken together are about equal in area to the county of Somerset, and their native plants comprise nearly 1400 species of flowering plants and ferns. Of that number more than 1000 belong also to the peninsula of Spain, and almost as many to Italy, France, and Algeria respectively, showing that when the vegetation is compared as a whole with that of neighbouring countries, an evident fact is that, excepting some species that are entirely special, and some others rare and little known that give to it a peculiar character, the flora of the Balearic group is very closely allied to that of the countries named. But the striking feature of this flora is that it contains about 40 species known to grow only in one other country, and 50 which are at present unknown elsewhere in the whole world.

At 9 A.M. on 21st April we left Paris for Barcelona, and twenty-four hours later set foot in that big Spanish port. There was time to look around, and for calls at the steamboat office and a bank; and it may be useful to note that one gets at least a *peseta* more for an English sovereign in Barcelona or Palma than is given in London. At 2 P.M. we were off for Minorca in a small steamer with very small engines, a good deal of cargo, and a good many hours allowed for the voyage.

We rolled along over the waves at about eight or nine knots an hour. My doings for the rest of that day and the night following are of no particular interest to anybody, but there was then developed the sole tinge of sadness that pertains to my recollection of the trip. Going on deck next morning we were running along under the low rocks of Minorca, and presently entered the splendid harbour of Port-Mahon, passing on the left the graves of our soldiers for whose loss, and that of the forts they defended, Admiral Byng was condemned and shot. Masses of warm grey rock, houses tier above tier—dazzlingly white, with red roofs and bright green shutters,—the "sapphire sea" below, and a sky of as deep a hue above, formed a scene not easy to describe, but which is familiar to most Mediterranean travellers. Before the vessel had moored we were boarded and welcomed by Don J. Rodriguez, the veteran naturalist, whose name is indelibly impressed on Minorcan botany. He had been advised of our coming by my old friend Mr. E. M. Holmes, well known in Mahon and elsewhere as "le premier algologue Anglais." After lunch, three gentlemen, botanists of Mahon, were introduced, and under their guidance we at once started on a walk to Cala Mesquida—a lovely bay four miles to the north-east, where many rare plants abound. On rocks skirting the road we saw a big shrubby wormwood (*Artemisia arborescens*), the largest European species, and *Capparis spinosa*, not yet in flower. Next, *Ferula communis*, a gigantic umbellifer nine feet high, two species of *Frankenia*, and two of *Asphodel*. The smaller asphodel (*A. fistulosus*) is only about a foot high, while the larger (*A. albus*) reaches four to five feet, and is among the commonest, as well as the most ornamental, plants in the islands, growing everywhere indifferently on the highest hills or on ditchbanks in the lowlands. It appears that this plant bears locally three different names at three stages of its growth. Before the flowering stem appears it is "Purrasa," when flowering it is called "Au Bo," and finally, when dry, "Caramusha." My informant insisted on this being written down, as he knew no similar instance. A strong spinous shrub bearing delicious-looking yellow fruit, much like a small choice apple, next arrested

attention. This proved to be *Solanum sodomæum*, an introduced species, and the fruit were "Dead Sea apples," handsome to look on but utterly uneatable. Passing over some low hills we reached the beautiful coast and came upon a wealth of rare plants. Yellow masses of *Ononis crispa*, most viscid and glandular, which when pressed seems to incorporate itself with the paper into one sticky mess; *Senecio Rodriguezii*; *Digitalis dubia*, a pale-coloured foxglove, very soft and velvety; *Euphorbia imbricata*; *Lavatera minoricensis*; and *Vicia bifoliata*,—all were found within a small compass. These are special Balearic plants, and the two latter grow only at Cala Mesquida. The fragile, filiform stems of the little vetch have to be extricated from the midst of prickly bushes, up through which they invariably grow, and to obtain them uninjured one must exercise all that patience and restraint in language for which the field-botanist is noted. The number of spinous and prickly plants in the locality was remarkable. Thorns and prickles prosper well in that country, and fences are cheap and good. A thicket of *Oxycedrus juniper* overgrown with *Smilax* is quite unapproachable. But besides those, the *Calycotome spinosa*, *Juncus acutus*, and other well-known species, there were scattered about among the stones many inviting mossy-looking cushions of close texture, hemispherical in shape, and often four or five feet in circumference, tempting the weary pedestrian with their apparent softness. But far from affording a comfortable seat to the wayfarer, these cushions of *Astragalus poterium* are masses of interlacing needles, among which the small white flowers appear. Other similar but coarser cushions are formed by plants of *Sonchus spinosus*. From neither is it possible to prepare satisfactory specimens for the herbarium. *Asparagus horridus*, too, consists of little else than two-inch spines, sharp, and so tough and strong that I had to tread portions under foot to flatten them enough for pressing. Yet the young shoots of this plant are tender and edible, and they appeared to furnish all the table asparagus that was served during our stay in the islands. The coast thereabout reminded one of the choicest Channel Island scenery, but is even more rocky. Minorca is a solid mass of stone.

The exposed surfaces weather in a curious way into sharp knife-edged ridges, and loose fragments lie in profusion everywhere. Returning in the twilight from that first excursion over a specially rough hillside, I asked one of our guides if the whole island was of that nature. "Oh no," he said, "not at all, in many parts it is quite different—far more stony!" Quarrying is unnecessary, for building material lies at hand in plenty, and the difficulty is to clear land for cultivation. Thick walls bound the fields, and walls are often built around fruit trees with the double purpose of giving them protection and of getting rid of the stones. Rubble masonry in the islands is marvellously well built and durable without mortar, and immense labour and patience are displayed in terracing hillsides for agriculture. But the people have been always skilful in the handling of stone, for does not ancient history tell us that the Baleares were the champion slingers of the world? Possibly they were more successful with their native pebbles than when, later, they took to using leaden balls, for one historian goes so far as to say that the lead melted in the air from the extreme violence with which it was slung.

And the prehistoric masons of Minorca in remote antiquity possessed the art of building in high perfection. Their monuments, the "talyots," "taulas," and "navetas," built of hugh blocks and slabs, are well preserved at this day. They are peculiar to the Balearic Isles, have no affinity with the megalithic remains in other countries, and their purpose can only be conjectured.

The next morning we drove to Albufera. The dusty wayside was bright with flowers, among which Boraginaceæ were prominent. The deep blue of borage, the varying violet and purple of many species of *Echium*, and the quieter hue of *Cynoglossum pictum* furnished much of the colour. In striking contrast arose here and there tall spikes of *Celsia cretica*, the most showy plant in Minorca, with blossoms as large as a crown piece—yellow, blotched with red. Other good things gathered thereabout included *Lepidium Carrerasii* (peculiar to Minorca), *Salvia clandestina*, *Ephedra fragilis*, *Ornithogalum arabicum*, *Briza minor*, and some rare Leguminosæ.

Several of our commonest species at home—such as the dandelion, daisy, and deadnettle—are entirely absent from the islands. Their places are taken by plants of very different character. On waste ground everywhere is a pretty, graceful sort of thistle (*Galactites tomentosa*): and quite as common is the squirting cucumber (*Ecbalium Elaterium*). Sufficient of the drug grows wild in Minorca to supply the needs of a century at the present rate of consumption.

There is no pasture in the Balearics, and therefore few of the grasses that make our English hay,—no cats'-tails, fox-tails, or dogs'-tails, nor, in fact, any species with the name *pratensis*. And, as a consequence, there are no milch cows and no butter. Goats, pigs, and sheep pick up what they can among the rocks, by the roadsides, and on the stubbles. Sheep, as the most dainty feeders, come off the worst. As they wander over the stones, gaunt and hungry, pitiful objects, with every rib showing, they tell you plainly that it is useless to ask for mutton-chops in the islands. Cow's milk, beef, and butter are city luxuries, to be obtained only by much favour and many *pesetas*. The universal custom is to breakfast on a peculiar rich, light bun or cake called "ensiamada," which is much more readily eaten than described. It is slightly indigestible, and with coffee or chocolate stands by one well until the midday meal.

It is vain to look for English hedgerow flowers that beautify our deep lanes and wood-borders in the springtime. There are no sweet violets, bluebells, or red campions; no golden celandine, stitchwort, or blue speedwells. We bruise no broad-leaved ramsons under foot and sniff their odour. Nor does marsh-marigold edge willowy copses with its splendid flowers. No upland fields are gay with gorse or daffodils, nor in the south does "modest woodruff scent the mossy shade." But yet our British hawthorn seems quite at home, flowering in April. We noted also the blackthorn, large nettle, and some docks. Oddly enough, the whole six Balearic geraniums are common Bristol plants. In all else no vegetation could be more unlike. The hillsides are covered with red and white *Cistus*, lavender, *Genista*, mastic, and big shrubs of heath

and rosemary and myrtle; while the undergrowth is often of several species of *Helianthemum* and labiates, sprinkled with white flowers of *Cyclamen balearicum*, the "San Pera Violet" of the natives. Here and there is a clump of the curiously jointed *Ephedra fragilis*, a juniper, a pomegranate, or a fig springing wild from clefts in the rock. Interesting and beautiful as are all these, they are excelled in Minorca by the plentiful and luxuriant *Euphorbia dendroides*, a most elegant bush when in bloom. The stem of this species is quite woody, and sometimes a foot or more in circumference. It rises in regularly three-forked branches into a beautiful pale green hemisphere five or six feet high. The largest trees are of *Quercus Ilex*. Exposed to the constant sea-gales, these are all bent and twisted to the southward by the prevailing wind. *Pinus halepensis* is the only native pine. Smaller and less picturesque than the cultivated species, it yet affords a pleasing prospect from the light green of its soft outspreading tufts of leaves.

The mastic (*Pistacia Lentiscus*) in the Balearics, as on the Riviera, forms as a mere bush the chief constituent of the underwood. But a very old tree was pointed out to us in Minorca as one of the largest in existence. Its branches covered a space about thirty feet in diameter, which would make it probably as large as the celebrated tree at Bordighera. In cultivation, instead of clover-fields, one sees great sheets of the vivid crimson flowers of *Hedysarum coronarium*, the Minorcan forage plant that has been found well suited to a dry and windy climate.

At Albufera we came to a large fresh-water lake, with some brackish marsh between it and the sea. Here was abundance of *Leucojum Hernandezii*. We saw it later in Majorca, but elsewhere it grows only in Sardinia. Near the water's edge were *Salicornia fruticosa*, and *Suæda fruticosa*: and close at hand *Lavatera cretica*, *Lotus creticus*, *Melilotus messanensis*, *Vicia atropurpurea*, and *Scrophularia ramosissima*. On the shore were also some enormous tamarisks of great age; some of the trunks being ten to twelve feet in circumference. One object of this day's excursion was to obtain the *Daphne vellœoides*, Rodrig., abundant on the Isla Colom. Landing on that island from a fisherman's boat we immediately came upon plenty of the

rare and beautiful little shrub, bearing small white flowers low down upon the branches, and very evidently distinct from all other daphnes. This reflection applies to all the Balearic rarities without exception. These endemic species are remarkable for the strikingly decided characters that separate them from their congeners. They indeed are "species of the first order." Hardly had our boxes closed upon the daphne twigs, than a fine *Arum* was sighted (*A. muscivorum*),—its spathe resembling a hog's ear, reddish, and very hairy. Here also many bulbs of the great squill (*Urginea scilla*) protruded from the scanty soil in all directions, some as big as a child's head. I learnt that the natives are well aware of the medicinal properties of squill, and, moreover, have the practice of keeping a plant upon the staircase of each house as a charm against erysipelas. Then appeared the proprietor of the island, a singular figure. Clad in rags, rope sandals, and a battered straw hat, he was yet monarch of all he surveyed on that lonely rock. He was at pains to explain to us that our lovely *Arum* was a pest in his domain, and how fortunate it was that pigs would eat it, and indeed liked it.

On the following day, by the kindness of a local landowner, we were enabled to visit the Barranco de Algendar. Outside Mahon we met a fisherman running at full speed with a heavy basket on his back, and were told that the custom was always to run into town with a catch, sometimes from ten miles out. Our guide remarked further that his countrymen were a hardy race. The island, he said, swept by cruel winds and lacking water, produced barely enough to sustain the inhabitants. They therefore could never make full use of their digestive apparatus, and as most diseases, he believed, arose from keeping it too thoroughly employed, good health and long life resulted. The consumption of alcohol, however, threatened trouble, amounting as it now did annually to two dollars per head of the population. I fancy that there would be consternation here at home also if our use of intoxicants stood at that same figure, but the trouble would be in the national exchequer, and not in the temperance councils. But I feel sure that my Minorcan friend did not wish to be taken seriously. A land that can produce three crops of potatoes,

and that, wherever scratched by a primitive wooden plough, is stated to yield half as much again as a similar area would upon the mainland, should not be despised. Any community that adheres to the main principles of temperance, plain living, and abundant exercise, will of necessity be hardy and long-lived.

The famous Barranco is a fissure, or cañon, riven through the plateau of miocene rock that occupies the whole of southern Minorca. Following a sinuous course of six or eight miles from near the centre of the island to the coast, its pinnacled rocks and precipices, two or three hundred feet high, are grandly picturesque. A stream threads the bottom of the gorge, and cliffs alternately close in to make a dark narrow cleft through which the water rushes like a millrace, or open out that the sun may play on the orange gardens and subtropical vegetation that flourish at the bottom of the moist ravine, where the air is always soft and warm. Sheltered entirely from the high winds of the uplands above, this is one of the few spots in the island where palms and citrus fruits can reach perfection. *Laurus nobilis* attains the height of fifty feet, and rare plants are frequent along the rocky escarpments. *Pæonia corallina* abounds, a variety differing from our Steep Holms plant by its glabrous follicles. A decoction of the root is much used as a remedy for epilepsy. *Delphinium staphisagria* also is plentiful, and *Urtica pilulifera*, the most vicious and venomous of nettles. Other new species met with that day were *Viola stolonifera*, *Lotus tetraphyllus*, *Ononis minutissima*, *Sibthorpia africana*, *Micromeria Rodriguezii*, *M. filiformis*, *Scolopendrium Hemionitis*, and *Selaginella denticulata*.

One of the last rambles from Mahon took us westward along the harbour to Villa-Carlos, a suburb founded by the British under the name of George Town. Here stand our soldiers' deserted barracks, untenanted since the occupation. When an English ship of war visits the place, the bluejackets play football in the barrack square under windows from which their compatriots looked out a century and a half ago. Two *Mesembryanthemums* (*crystallinum* and *nodiflorum*) grow here on rocks by the sea, and the curious *Ophrys speculum* that has a mirror-like patch on its

labellum. As we were discussing by the roadside a peculiar *Chlora* that seemed new to us, some Menorquins passed, and their remarks were translated by our companion as follows:—"Oh yes, they are Americans. Most of the medicine that people take nowadays comes from America. They travel here and gather our weeds, and compound the remedies on their return."

Time will not permit me to do more than mention many things that could not escape observation — the dazzling cleanliness of the towns, the courtesy of the people, and their kindly feeling for everything English, and beyond that the manifest traces of a still existing influence of the old British occupation.

We left Minorca feeling that we would fain have stayed forty days instead of four, both on account of the intrinsic charm of the place and the extreme kindness that we received from our Spanish *confrères*.

After a starlight passage on the night of the 27th, the sun rose as we entered Palma Bay, and its rays fell on the capital of Majorica, its great Gothic cathedral, its windmills, and its palms. A more enchanting scene cannot be imagined.

Majorca is the largest and most fertile of the islands. The soil is so rich, the climate so soft, and the natural scenery so beautiful that many endearing names have been bestowed upon it throughout the ages. Approached from the sea the aspect is more Oriental than European. And the more prominent vegetation—the abundant *Agaves*, prickly pears, caroubs, and fine date-palms, as also the dwarf native palmetto (*Chamærops humilis*) which covers many wild rocky slopes by the sea—all give an Eastern colouring that harmonises well with the old Moorish buildings, and with the fine mountains that glow in blues and purples beyond the Palma plain. This great plain, protected on the north and east by high ranges, of which the most elevated peaks reach 5000 feet, is closely cultivated, and produces a long list of vegetables, cereals, and fruits. The attention of a stranger is arrested by the number of wind-sail pumps used for irrigation, and by the universal practice of planting almond and fig trees in the cornfields. The pruning of these fruit trees leaves them

open in the centre to the sun, so that the amount of shade thrown in that brilliant climate is insignificant, and may even be beneficial to the crops. As regards other trees, *Quercus Ilex* and the small native pine cover large tracts among the mountains, whilst the olive is more abundant in the lower regions, where it appears to have been cultivated from very ancient times. The giant olives of Valdemosa certainly must have been planted by the Moors, possibly a thousand years ago. Gnarled, twisted, and contorted into fantastic shapes, the heartwood gone ages ago, and the outer shells, though still vigorous and sustaining tall stems, often split into three or four separate trees now standing several feet apart, these extraordinary trees are more suggestive of a monstrous vegetation imagined by a Doré or a Dante than of symbols of peace and amity. Of native timber in our sense of the term, there is none in Majorca. The antiquated and expensive system of cooking by charcoal still prevails throughout the islands, with the result that practically all the large trees have been destroyed by the charcoal burner. A truly lamentable result of the demand for this costly and unwholesome fuel is that the beautiful Balearic box-tree (*Buxus balearica*), known only in Majorica and at one small spot in Spain, a handsomer and more elegant plant than our British species, has been almost completely destroyed. At one time it is said to have formed actual forests among the mountains. Some of the trunks attained the size of a man's body and furnished wood for cabinetmaking; but about the year 1851 they were all cut down and converted into charcoal. At the present time, a few small bushes merely are scattered over the cordillera of the north. We ourselves found only two.

I am not going to weary you with a detailed account of excursions in Majorca, but will only note briefly the richness of our gatherings in the few localities we were able to visit. On the shores of Palma Bay and the slopes under Belver Castle grow a large number of rare plants, viz. *Silene cerastoides*, *S. rubella*, *Arenaria procumbens*, *Helianthemum umbellatum*, *H. Serræ*, *H. salicifolium*, *Fumana Spachii*, *Paronychia argentea*, *Anthyllis cytisoides*, *Ononis breviflora*, *Hedysarum spinosissimum*, *Bubocastanum incras-*

*satum, Linaria triphylla, Lavandula dentata, Sideritis romana, Avena bromoides, Lamarkia aurea, Ægilops ovata,* and *Æ. triaristata.*

Passing across the island to the mountain village of Pollensa, we made our way up the beautiful Val de Ternellas as far as Castel del Rey, and met with many Balearic specialities, viz. *Hypericum balearicum, Rhamnus balearicus, Rubia balearica, Smilax balearica, Polygala rupestris, Alkanna lutea, Vincetoxicum nigrum,* and *Chamærops humilis.*

From Pollensa, also, we reached the charming hamlet of Ariant, lying to the north-east amid a circle of towering rock pinnacles. By the mule-path over the Col we saw *Delphinium pictum,* not yet in flower, and masses of *Phlomis italica.* On the coast, beyond Ariant, we were successful in finding the most interesting plant of the whole trip, the very latest discovery in the Balearic flora. Six years ago Mr. Clarence Bicknell, on a journey through the mountains with mules, strayed from the track in a fog, and so came upon a new species of *Pimpinella* that now bears his name. Prior to our visit, no botanist but himself had seen this plant growing, and without his instructions we should not have found the place. Sheltered among huge masses of rock fallen from stupendous precipices above, at a spot where another thousand feet of cliff shelves down to the sea below, *Pimpinella Bicknelli* is safe enough from man's interference. Although of robust habit, it may, of course, be a decadent or dying-out species, under ban of some inexplicable natural limitation; but if so, its destiny will be worked out alone amid the solitude and desolation of that grand north coast. My fond hope is that some day I may revisit the spot at a time when the plant shall be in fruit, for that had not developed in April.

For the rest, there might be much to say on the beauty of Miramar, preserved in its pristine wildness by the Austrian Archduke Ludvig Salvator, a distinguished scientist and the friend of all naturalists, who has there a house filled with Majorcan antiquities and works of art. On his domain we first saw *Hippocrepis balearica, Brignolia pastinacæfolia,* and *Allium subvillosum.* And of charming Soller, too, the "Garden of the Hesperides," where loaded orange boughs bend to the earth, and the cool evening air

is heavy with rich perfume of many flowers. All the fruit-trees of Europe seem to flourish side by side in the groves of Soller. There we climbed on to the Sierra, to the Col de Lofra, a twelve hours' tramp, to be rewarded with *Brassica balearica*, *Genista cinerea*, *Taraxacum obovatum*, and *Helichrysum Lamarkii*. There also we scrambled in the torrent-bed of the Couma to get *Helleborus lividus*, *Pastinaca lucida*, *Linaria fragilis*, and *Scutellaria Vigineuxii*, the most delicate of labiates. Very few folk indeed have ever met with the latter, for which one has to crawl between the boulders into crevices deep and damp. And apart from botany, it is delightful to walk about the streets and look through widely-open doors into the great tiled halls, spotlessly clean, and gay with palms and flowers, and get a glimpse at the far end of oranges and pelargoniums beyond. All the houses, rich or poor, stand wide open all the time, as if the people were ambitious to show off their neatness and good taste to every passer-by. Door-bells are unknown and knockers rare. If no one be at home, the doors remain open just the same. The friendly, simple people are everywhere good-natured and anxious to please. Not a beggar, lout, or ill-behaved person did we see in that fascinating land, where men and customs change but slowly, and where the people have all the virtues of those who mix but little with the outer world. They do not know the American or British tourist; no preparation has been made for him, and no one speaks his language. Who shall say that his coming is greatly to be desired?

EXCURSION OF THE SCOTTISH ALPINE BOTANICAL CLUB TO FORT-WILLIAM AND ARISAIG, JULY 1903. By ALEXANDER COWAN.

(Read 11th February 1904.)

The Club met on the evening of Monday, 27th July, at the Chevalier Hotel, Fort-William, and devoted Tuesday, the 28th, to Ben Nevis, where a pleasant day was spent in exploring the corrie. The Members were accompanied by Mr. Symers M. Macvicar, and they are greatly indebted to

him for much useful information regarding the botany both of the neighbourhood of Fort-William and of Arisaig. The day was fortunately fine, but, apart from the usual varieties of ferns found on high mountains, little of interest was found, except—

Cerastium trigynum,
Euphrasia scotica,
E. gracilis;

also a plant of *Athyrium alpestre*, var. *flexile*, and a very crispy variety of the Parsley fern, *Allosorus crispus*. Of ferns seen—

Lastrea dilatata alpina,
Athyrium alpestre, and
Allosorus crispus

were found in great abundance and luxuriance.

On Wednesday, 29th July, the Members journeyed to Arisaig by the forenoon train, and made the Arisaig Hotel their headquarters until Saturday, 1st August. The afternoon of this day, Thursday the 30th, and Friday the 31st were spent in the neighbourhood of Arisaig, permission having been granted to the Members to botanise on the low ground of the Arisaig property by Mrs. Nicholson, the proprietress. The following are the principal plants found near Arisaig:—

Blysmus rufus.
Callitriche platycarpa.
Centunculus minimus.
Carex fusca.
C. filiformis.
Drosera anglica.
D. rotundifolia.
D. obovata.
Hymenophyllum tunbridgense.
H. unilaterale.
Juncus maritimus.
Lastrea æmula.
Pinguicula lusitanica.
Pyrola media.
Rubus saxatilis.
Salix pentandra.
Scirpus Tabernæmontani.
Veronica scutellata.

The Members left on the morning of Saturday, 1st August, having spent a very pleasant and interesting week, its latter days in a district which had never before been visited by the Club. The weather was, fortunately, all

that could be desired, though in other parts of the country this week was an exceedingly wet one. Although the list of rare plants found is not a very long one, still some of them are of great botanical interest, and well repaid the Members for their visit. The only rare plant reported to exist in this neighbourhood, but unfortunately not found by any member of the party, is *Carex bœnninghauseniana*. On the other hand, a rare plant was discovered in the district, not hitherto reported upon.

*Note.*—With regard to *Centunculus minimus* found by Mr. Boyd, it is interesting to note that, according to Dr. Boswell Syme, the plant has never previously been found so far north in Scotland.

## Notes on the Origin of Lenticels, with Special Reference to those occurring in Roots. By J. A. Terras, B.Sc. (With Illustration.)

(Read 14th April 1904.)

That the initiation of those secondary meristematic divisions which give rise to cortical phellogen is intimately connected with, and probably dependent on, the mechanical stresses set up by secondary growth in thickness, is at least indicated by the constant association of the two cambial rings, the formation of bundle cambium always preceding that of phellogen. If this be granted, it is natural to suppose that the form and structure of the cells resulting from at least the earlier divisions of the phellogenetic initials must to a certain extent depend on similar stresses; while in the case of later divisions, the form primarily impressed on the initial cells will be retained under the influence of inheritance long after the casual stresses have been removed. That such a fixation of characters impressed on meristematic cells by external and temporary causes is common in tissues, is sufficiently indicated by the phenomena occurring in the case of scar formation where injury to a dividing meristematic cell causes it to form daughter cells differing in character from those originating from similar but uninjured parents. The difference so produced may persist throughout life, or at anyrate long after the disappearance of the exciting cause and even of the cells originally injured.

. . .

In most phellogens two distinct kinds of tissue formation may be recognised, viz. that characteristic of normal cork formation and that which gives rise to Lenticels.

The initial divisions which set up these two types of tissue formation take place under very different external conditions.

Those phellogen initials which will ultimately give rise to typical cork cells undergo their first divisions beneath a continuous epidermis and cuticle which exerts a high radial stress on the dividing elements, while, on the other hand, a Lenticel initial may be regarded, from a purely anatomical point of view, as a phellogenetic element in which division is relatively unhampered by external mechanical forces. That this merely mechanical aspect of the case is necessarily complicated by internal physiological processes, such as conditions of intercellular nutrition, transpiration, etc., as well as by external, environmental, and probably also phyllogenetic relationships, will be denied by no one. But, as even the approximate solution of such a problem as the causation of lenticellar formation is for the present quite unattainable, I desire to direct attention solely to those mechanical relationships of position and pressure which undoubtedly play an important part in the origin of these structures.

As Stahl pointed out, the first corkcambial divisions take place in cortical cells occupying positions in which Lenticels ultimately arise. The first cortical cells to re-enter the meristematic condition are therefore those which give rise to Lenticels, indicating that the environment of these elements is better suited for the promotion of cell division than is that of normal phellogen initials.

A consideration of the form exhibited by individual cells resulting from meristematic division within a lenticellar area leads to the conclusion that one of the factors in this environment, which makes for cell division, is a reduction of external pressure. This view is also supported by the irregularity of the meristematic divisions from which the rounded, loosely aggregated, complementary cells are formed. While in other portions of the phellogen there is but one initial layer; the meristem underlying a Lenticel is usually composed of several radially disposed cells, all undergoing tangential division.

The circumstance that the divisions taking place in normal lenticellar meristem are not only more numerous than those characteristic of most phellogens, but are also more markedly centripetal in direction, the greater number of cells being formed towards the outer side of the phellogen, may perhaps also be taken as at least partial evidence in favour of the view that in these areas the inward epidermic pressure is minimal, though obviously many other causes must be active in determining such relationships.

The question of the suberisation or otherwise of the complementary cells relates rather to the functions performed by them than to the form which they exhibit, and which must at least in part be looked upon as a manifestation of the stresses to which their initial cells were subjected during division. The only compression stress to which the cells of an approximately superficial meristem like a normal hypodermic phellogen can be exposed during the period of lenticellar formation must be the pressure exerted by the elastic epidermis and cuticle; a pressure which along with its main cause, viz. secondary growth in thickness, is at this season nearing, if it has not already reached, its maximal value. The tangential tension due to this cause often amounts, as pointed out by Pfeffer, to as much as ten atmospheres, and as the radial pressure resulting therefrom varies directly as this value, and inversely as the square of the radius, it must in a narrow stem reach very considerable dimensions.

The relations of position which points of lenticellar origin bear to other plant organs have also to be taken into consideration, as on these must to a large extent depend the pressures to which the lenticellar initials are subjected.

In the great majority of stems with superficial periderms, the primary lenticellar divisions take place in cells lining the air space below a stoma, or group of stomata. In such a position there can be little if any radial pressure on the dividing cells, as their free surfaces abut on a cavity communicating with the atmosphere by an aperture, which must itself constitute a point of weakness in the epidermis.

That the elements originating from these cells ultimately rupture the stoma and tear the surrounding tissues, scarcely

affects the argument, as once division has been set up, and the meristematic condition definitely assumed, the lenticellar elements, from being merely passive structures acted on by pressures induced by a relatively distant cambium, enter an active condition, and in their turn exert positive pressures on the inactive tissues in their neighbourhood. In the case of stems with deep periderms the relation between the structures is more complicated, but even here, according to Devaux, the Lenticels arise beneath subtending stomata. The intervening tissue, though possibly rendering the release of pressure due to the stoma more diffuse, can hardly exert any marked pressure on its own account, so that in this case also the active stresses are those due to the epidermis.

The origin of Lenticels on leaf scars, as in *Abies pectinata*, Daphne, etc., though still requiring further elucidation, also seems to point in the direction of initiation under conditions of minimal pressure. In these cases the Lenticels apparently arise before the fall of the leaf, in the phylloptotic phellogen, and are therefore in a position in which radial pressure is greatly reduced owing to the absence of an elastic epidermis, while the base of the leaf, largely composed of dead parenchyma, can scarcely exert any great force on the surface of the abscission layer.

Those Lenticels which occur in pairs, one on each side of a leaf scar but apparently external to it, still require more accurate investigation, with the object of determining their point of origin; as it may possibly happen that they will ultimately fall to be included in the same category as those of Abies and Daphne.

As regards the Lenticels described by Weiss in stems of monocotyledons where they bear a definite relation to the axillary buds, further information is also still required.

We have now to consider the conditions under which Lenticels arise in roots. As Devaux points out, these are always situated at the bases of lateral rootlets lying either to right and left or directly above and below them.

The accompanying figures, however, show that this is but a partial statement of the case, so far at least as concerns the point of origin.

The primary Lenticels of a root normally arise beneath

the cortex of a young lateral rootlet, in that region where the phellogen of the old root crosses the cortical tissue of the branch in order to establish communication with the corresponding layer of the latter. All the tissue primarily outside this phellogen, whether on the old root or the young one, is ultimately exfoliated. In this case, however, unlike that of the stem, the normal phellogenetic divisions precede slightly the formation of the lenticellar meristem, with the result that, though the external cortex is not entirely thrown off at the period when the lenticellar initials begin to divide, its cells have already lost their turgidity and begun to wither, owing to the formation of internal cork. The primary cortex of the young root is, moreover, separated from that of the parent by a cylindrical fissure extending from the surface of the latter to its phellogen, and it is on the ring-like area lying between the base of this fissure and the central cylinder of the young root that the Lenticels arise.

The divisions taking place in this area are tangential to the old root, and due, as above mentioned, to the necessity of uniting the two phellogens so as to provide a continuous cork covering, but do not arise in a definite pericycle, the cells of which have in this region been utilised at an earlier period for the production of the lateral root. For the same reason there is no endodermis above the dividing cells, and the only radial pressure to which they are exposed is that set up by the rapidly withering cortex of the branch root, a stress which in any case cannot reach large dimensions, and is further reduced by the presence of the cylindrical fissure above referred to. The cells of the normal phellogen, covering the remainder of the parent root, are on the other hand subjected to the radial pressure of an elastic endodermis together with that of the other cortical layers.

The surface in which the cortex of the young root comes in contact with the phellogen of the parent has been already referred to as a ring lying between the central cylinder of the young root and the cylindrical fissure separating the two cortices.

In the majority of cases the lateral rootlet is considerably the thinner of the two, and where this is so, the superficial curvature of the parent may, for the present purpose, be

considered a negligible quantity so far as the area of origin of the branch rootlet is concerned.

The ring on which the Lenticels may arise is then flat, and the radially directed pressure must be practically the same over the whole of its surface. It is precisely under these conditions that Lenticels tend to occur above and below the young rootlet, as well as laterally and obliquely.

When, on the other hand, the branch rootlet is so large relatively to the parent as to cause the ring-like surface of contact to become an ellipse curved round the cylindrical surface of the old root, then the conditions are considerably altered, and the areas of minimal pressure come to be situated at the sides of the lateral rootlet not above and below it.

In such cases lateral Lenticels alone are formed.

That this rule is not constantly adhered to is probably due to the abortion of some of the possible Lenticels, an occurrence which may take place at any time, so that, even when the rootlet is relatively quite thin, it often happens that only two lateral Lenticels can be discovered, or indeed only one may appear, either to right or left of the base, or there may be an entire absence of Lenticels in a moderately old root.

The roots of a considerable number of plants were examined with respect to the point of origin of their Lenticels, but by far the most instructive preparations were obtained from roots of Alder growing naturally in water. In these the cortex remains in position for a much longer period than in the case of roots from a drier environment, thus rendering the relations between the Lenticels and the cortex of the lateral rootlet more easily discernable.

That the exceptional mode of life of these roots does not cause any abnormality in the Lenticels, so far at least as their position is concerned, is shown by the occurrence of similar relationships in roots from ordinary soils. It is, however, considerably more difficult to obtain good preparations of these, as the cortex of the lateral rootlet is usually cut off by the pericyclic cork very soon after the primary division of the lenticellar initials has taken place. The cortical tissue then dies, and at the same time shrinks considerably, causing the Lenticels to lie apparently outside

it. This shrinkage is, however, in most cases easily allowed for, as it is naturally greatest at the base, the oldest part, of the rootlet.

So far, the position of primary Lenticels alone has been discussed, but as the root increases in thickness, secondary structures of the same kind arise at apparently indeterminate points of the surface.

It is difficult to obtain any clue to the causes underlying the formation of these organs, and though the determination of their points of origin may possibly depend on accidental rupture of the cork covering, and the formation of new initial areas beneath the old phellogen, this is only a suggestion with hardly any evidence to support it.

Apart from the effect of pressure on the initial cells, another partial cause of lenticellar formation is to be found in excess of moisture, either in the form of water or of moist air.

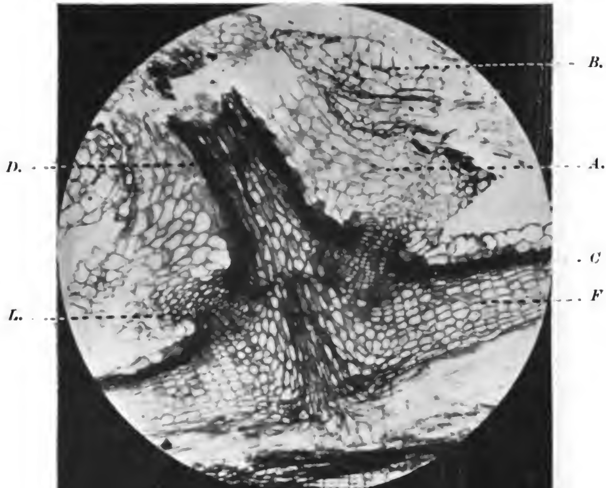
The best evidence of this is perhaps to be found in the hypertrophy of lenticellar organs in moist situations.

When a stem or root bearing Lenticels is placed in water or suspended in a saturated atmosphere, the division of the lenticellar initials often becomes so accelerated, and the cohesion of the complementary cells so increased, as to give rise to the formation of long worm-like outgrowths of ærenchymatous tissue, which may easily be mistaken for roots, though undoubtedly true roots may arise beneath the Lenticels at a later period.

The numerical proportion which the Lenticels on the lower side of a branch bear to those on the upper varies within somewhat wide limits, as the following numbers taken from Devaux will show:—In a three-year-old shoot of Lime there were 6·7 Lenticels per square centimeter on the upper surface and 7·7 on the lower, while in a one-year-old shoot of Alder, the upper surface bore 9·7, the lower 10·8, in the same area. It is interesting to notice that a three-year-old branch of the same tree had 4·6 on the upper as compared with 3·7 on the lower.

These numbers do not indicate any very marked difference, and, in ascribing that which does exist to differences of moisture, it must be borne in mind that in many cases the growth in thickness of a branch is greater on the upper

Fig. 1.



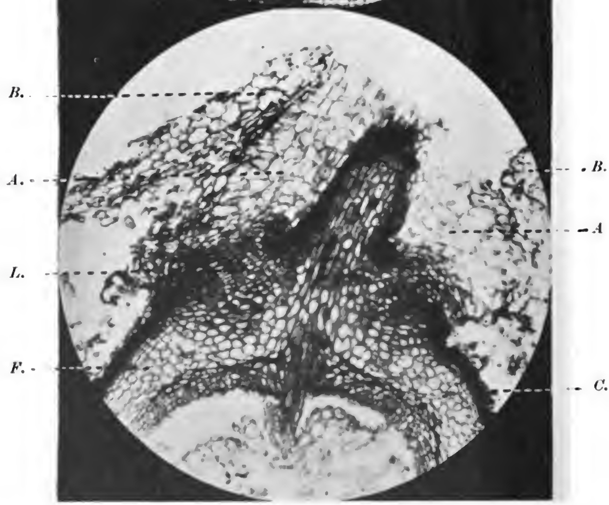




Fig. 2.

than on the under side, often very considerably so, with the result that the Lenticel bearing phellogen is stretched over a wider area on the upper surface than on the under, and the number of primary Lenticels per square centimeter thereby reduced.

It may, however, be observed that in nearly every case cited with respect to the effect of reduction of pressure on Lenticel formation, an excess of moisture may also be assumed. As regards stomata, the air space on which the Lenticel initials abut is frequently filled with saturated air.

When a Lenticel arises beneath another tissue, such as the base of a leaf, or the cortex of a lateral root, the presence of that tissue above the dividing cells increases the amount of available moisture, and to that extent facilitates division. We may then conclude that at least one partial factor in the formation of lenticellar organs is the reduction of pressure above their initial cells, while another in all probability is to be found in the presence of moisture.

For the history and literature of this subject, Devaux's paper in the "Annales des Sciences Naturelles Botanique"[1] should be consulted.

[1] M. H. Devaux, "Recherches sur les Lenticelles." "Annales des Sciences Naturelles Botanique," ser. 8, t. xii. pp. 1-240, pl. 1-6. 1900.

## DESCRIPTION OF PLATE.

*A*. Primary cortex of lateral root.
*B*. Primary cortex of parent root.
*C*. Pericyclic phellogen of parent root.
*D*. Pericyclic phellogen of lateral root.
*F*. Secondary cortex of parent root.
*L*. Lenticel.

Fig. 1. Longitudinal section of a root of Alder (*Alnus glutinosa*) passing through the base of a young lateral rootlet, and showing two Lenticels placed vertically one above and one below the rootlet. The primary cortex of the parent root is already torn and almost cast off, that of the lateral rootlet is still adhering.

Fig. 2. Transverse section through a similar root, showing two Lenticels lying one to right and one to left of the rootlet.

In both figures the young Lenticels clearly lie beneath the cortex of the lateral rootlet.

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Dec. 1858. †Carruthers, William, F.R.S., F.L.S., *Central House, Central Hill, London, S.E.*
Feb. 1848. Christison, Sir Alexander, Bart., M.D., 40 *Moray Place.*
Mar. 1893. Christison, Lady, 40 *Moray Place.*
April 1848. Christison, David, M.D., 20 *Magdala Crescent.*
June 1873. *Clark, T. Bennet, C.A., *New Mills House, Balerno.*
Dec. 1856. †Cleland, John, M.D., F.R.S., *Professor of Anatomy, University of Glasgow.*
July 1896. Coldstream, Wm., B.A., B.Sc., *c/o Messrs. Coutts & Co.*, 59 *Strand, London*;—*Non-Resident Member, May* 1861.
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Mar. 1903. Cowie, William Beaverley, 26 *Clyde Street.*
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July 1869. *Drummond, W. P., 8 *Wardie Road.*
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Dec. 1860. †Farquharson, Rev. James, D.D., 47 *Mardale Crescent.*
Dec. 1858. †Fayrer, Sir Joseph, M.D., K.C.S.I., F.R.SS. L. & E., 16 *Devonshire Street, Portland Place, London, W.*
Feb. 1894. Ferguson, R. C. Munro, M.P., *of Raith and Novar, Kirkcaldy.*
April 1904. Finlayson, James, 8 *Thirlestane Road.*
Nov. 1861. †Foggo, R. G., *Kaimes Road, Murrayfield.*
July 1860. †Fox, Charles H., M.D., 35 *Heriot Row.*
July 1872. *Fraser, John, M.B., C.M., 13 *Heriot Row.*
Dec. 1865. †Fraser, John, M.A., M.D., *Chapel Ash, Wolverhampton.*
Jan. 1903. Fraser, J. C., *Comely Bank Nurseries.*
Dec. 1855. *Fraser, Patrick Neill, *Rockville, Murrayfield.*
Mar. 1862. Fraser, Sir Thomas R., M.D., F.R.S., *Professor of Materia Medica*, 13 *Drumsheugh Gardens.*
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Jan. 1881. Geddes, Patrick, F.R.S.E., *Professor of Botany, University College, Dundee.*
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Jan. 1889. *Grieve, James, *Redbraes Nurseries.*

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Dec. 1895. *Grieve, Sommerville, 21 *Queen's Crescent.*
Feb. 1879. *Grieve, Symington, 11 *Lauder Road.*
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June 1862. †Haynes, Stanley Lewis, M.D., *St. Michael's, Malvern, Worcestershire.*
Dec. 1860. ‡Hector, Sir James, K.C.M.G., M.D., F.R.SS. L. & E., F.L.S., *Wellington, New Zealand.*
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April 1886. Hill, J. R., *Secretary, Pharmaceutical Society, York Place.*
May 1867. *Hog, Thomas Alex., *of Newliston, Kirkliston.*
Feb. 1878. †Holmes, E. M., F.L.S., F.R.H.S., *Curator of Museum, Phar. Soc. of Great Britain, Ruthven, Sevenoaks, Kent.*
June 1893. Hunter, Robert James, 15 *Moray Place.*
Feb. 1891. ‡Jamieson, Thomas, 10 *Belmont Street, Aberdeen.*
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April 1883. Lindsay, Robert, *Kaimes Lodge, Murrayfield;—Associate, July* 1879.
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Jan. 1881. †Macfarlane, John M., Sc.D., F.R.S.E., *Professor of Botany, University of Philadelphia, U.S.A.*
Feb. 1886. M'Glashan, D., 11 *Corrennie Gardens.*
Feb. 1902. M'Hattie, J. W., 22 *Melville Terrace.*
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June 1880. *M'Intosh, W. C., M.D., LL.D., F.R.SS. L. & E., F.L.S., *Professor of Natural History, St. Andrews.*
Feb. 1902. Mackenzie, D. F., *Estate Office, Mortonhall.*
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Feb. 1882. M'Murtrie, Rev. John, M.A., D.D., 13 *Inverleith Place.*
June 1897. †Macvicar, Symers M., *Invermoidart, Acharacle, Fort-William.*
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Jan. 1899. Morton, Alex., B.Sc., 17 *Lutton Place.*
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April 1883. *Paul, Rev. David, M.A., LL.D., *Carridale, Fountainhall Road,*—FOREIGN SECRETARY.
July 1889. *Paxton, W., *Orchardton, Fountainhall Road.*
Mar. 1874. ‡Pettigrew, J. B., M.D., LL.D., F.R.SS. L. and E., *Professor of Medicine, St. Andrews.*
Nov. 1873. *Potts, George H., *of Fettes Mount, Lasswade.*
June 1893. ‡Pullar, Sir Robert, J.P., F.R.S.E., *Tayside, Perth.*
June 1891. †Prain, David, M.D., F.L.S., F.R.S.E., *Royal Botanic Garden, Calcutta.*
April 1904. Pottage, J. C., 8 *Corrennie Gardens.*
Dec. 1858. †Ramsbotham, S. H., M.D., *Fairstead, Ripon Road, Harrogate.*
July 1884. *Rattray, John, M.A., B.Sc., F.R.S.E., *Tullyburn Terrace, Glasgow Road, Perth.*
Jan. 1878. *Reid, Jas. R., C.M.G., 11 *Magdala Crescent.*

*Date of Election.*

Dec. 1869. *Robertson, A. Milne, M.B., C.M., *Hawea, Rodway Road, Roehampton, London, S. W.*

Dec. 1890. Robertson, Robert A., M.A., B.Sc., *Lecturer on Botany, Botanical Department, Bute Medical School, St. Andrews.*

June 1898. Russell, Dr., *Cadham, Markinch.*

Mar. 1902. Sampson, Hugh C., B.Sc., *P.O. Box* 855, *Pretoria, South Africa.*

July 1882. *Sanderson, William, F.R.S.E., *Talbot House, Ferry Road.*

Dec. 1887. ‡Scott, J. S., L.S.A., 69 *Clowes Street, West Gorton, Manchester.*

Dec. 1891. *Semple, Andrew, M.D., F.R.C.S.Ed., *Deputy Surgeon-General,* 10 *Forres Street.*

Jan. 1851. *Sibbald, Sir John, M.D., F.R.S.E., 18 *Great King Street.*

Feb. 1891. *Smith, J. Pentland, M.A., B.Sc., 21 *Oakshaw, Paisley.*

Jan. 1902. Smith, W. W., M.A., *Royal Botanic Garden, Edinburgh,*—HONORARY ASSISTANT-SECRETARY.

Feb. 1886. †Somerville, Alexander, B.Sc., F.L.S., 4 *Bute Mansions, Hillhead, Glasgow.*

Jan. 1890. *Somerville, William, Œc.D., B.Sc., F.R.S.E., 4 *Whitehall Place, London.*

June 1874. Sprague, Thomas Bond, M.A., LL.D., F.R.S.E., 29 *Buckingham Terrace.*

Nov. 1883. †Stabler, George, *Levens, Milnthorpe, Westmoreland.*

Dec. 1892. Stewart, Robert, S.S.C., 7 *East Claremont Street.*

Feb. 1902. Story, Fraser, *University College, Bangor, N. Wales.*

Feb. 1902. Tagg, Harry F., F.L.S., *Royal Botanic Garden, Edinburgh.*

Dec. 1887. Terras, J. A., B.Sc., 40 *Findhorn Place.*

April 1846 †Townsend, F., M.A., F.L.S., *Mem. Bot. Soc. Fr., Honington Hall, Shipston-on-Stour.*

May 1888. *Trail, J. W. H., M.A., M.D., F.L.S., *Professor of Botany, Aberdeen.*

Dec. 1888. Turnbull, Robert, B.Sc., *Board of Agriculture,* 4 *Upper Merrion Street, Dublin.*

July 1886. †Waddell, Alexander, *of Palace, Jedburgh.*

Dec. 1893. Waite, Percival C., 13 *Nile Grove.*

Jan. 1902. Wallace, John W., *Wallace Hall, Auldgirth, Dumfries.*

July 1884. Watson, William, M.D., *The Lea, Corstorphine.*

Feb. 1901. Whytock, James, *Palace Gardens, Dalkeith.*

Dec. 1901. Williamson, Wm., 4 *Meadowbank Terrace, Edinburgh.*

Dec. 1890. *Wilson, John H., D.Sc., F.R.S.E., *Greenside Place, St. Andrews;—Associate, Nov.* 1886.

May 1863 †Yellowlees, David, M.D., LL.D., 6 *Albert Gate, Dowanhill, Glasgow.*

Jan. 1903. Young, William, *Fairview, Kirkcaldy.*

## CORRESPONDING MEMBERS.

Jan. 1878. Areschoug, Dr. Fredrik Wilhelm Christian, *Emeritus Professor of Botany in the University, Lund.*

Jan. 1878. Ascherson, Dr. Paul, *Royal Herbarium, Berlin.*

Dec. 1881. Bohnensieg, Dr. G. C. W., *Conservator of the Library of the Museum Teyler, Haarlem.*

Dec. 1854. Brandis, Sir Dietrich, Ph.D., F.L.S., *Ex-Inspector-General of Indian Forests, Professor of Forestry in the University, Bonn.*

Mar. 1895. Brefeld, Dr. Oscar, *Professor of Botany in the University, Geheimrath Regierungsrath, Breslau.*

Mar. 1881. Caminhoá, Dr. Joaquim Montera, *Rio de Janeiro.*

Jan. 1866. Candolle, Casimir de, *Geneva.*

July 1879. Cheeseman, T. F., F.L.S., F.Z.S., *Curator of the Museum, Auckland, New Zealand.*

July 1879. Cleave, Rev. W. O., LL.D., *College House, St. Helier, Jersey.*

May 1865. Clos, Dominique, M.D., Corresp. de l'Institut, *Honorary Professor of Botany in the Faculty of Sciences, Toulouse.*

June 1902. Constantin, Dr. J., *Director, Jardin des Plantes, Paris.*

June 1902. Cramer, Dr. Carl Eduard, *Professor of Botany, Zurich.*

Jan. 1878. Eeden, Fredrik Wilhelm van, *Director of the Colonial Museum, Haarlem.*

Mar. 1895. Elving, Dr. Fredrik, *Professor of Botany in the University, and Director of the Botanic Garden, Helsingfors.*

Feb. 1893. Errera, Dr. Leo, *Professor of Botany in the University, Brussels.*

*Date of Election.*

Jan. 1878. Garcke, Dr. August. *Geheimrath Regierungsrath, Professor of Botany in the University, and First Assistant in the Royal Botanic Museum, Berlin.*

Mar. 1895. Guignard, Léon, Membre de l'Institut, *Professor of Botany, Paris.*

Jan. 1886. Haberlandt, Dr. Gottlieb, *Professor of Botany in the University, and Director of the Botanic Garden, Graz.*

June 1902. Hanbury, The Marquis Sir Thomas, K.C.V.O., *La Mortola, Ventimiglia.*

Dec. 1887. Hansen, Dr. Emil Christen, *Director of the Physiological Department of the Carlsberg Laboratory, Copenhagen.*

May 1891. Henry, Augustine, M.D., *Royal Gardens, Kew.*

June 1902. Henriques, Julio A., *Professor of Botany in the University, and Director of the Botanic Garden, Coimbra.*

April 1887. Horne, John, F.L.S., *Ex-Director of the Royal Botanic Garden Mauritius, Sea Braes, St. Clements, Jersey.*

Jan. 1886. Janczewski, Dr. Eduard Ritter von Glinka, *Professor of Plant Anatomy and Physiology in the University, Cracow.*

Jan. 1886. Luerssen, Dr. Christian, *Professor of Botany in the University, and Director of the Botanic Garden, Königsberg.*

June 1902. MacMillan, Conway, *Professor of Botany in the University of Minneapolis, and State Botanist, Minnesota*

June 1902. Maiden, J. H., *Director of the Botanic Garden, Sydney, N.S.W.*

June 1902. Mijoshi, Manabu, *Professor of Botany in the Imperial University, Tokio.*

Jan. 1873. Millardet, Dr. Alexis, *Professor of Botany in the Faculty of Sciences, Bordeaux.*

Jan. 1878. Oudemans, Dr. C. A. J. A., *Emeritus Professor of Botany in the University of Amsterdam, Arnheim.*

Dec. 1868. Radlkofer, Dr. Ludwig, *Professor of Botany in the University of Munich.*

June 1902. Raunkiær, Christen, *Assistant in the Botanic Garden, Copenhagen.*

Mar. 1881. Rodrigues, Dr. Joas Barboza, *Director of the Botanic Garden, Rio Janeiro.*

Feb. 1876. Sodiro, Luis, *Professor of Botany in the University, Quito, Ecuador.*

Mar. 1895. Stahl, Dr. Ernst, *Professor of Botany in the University, and Director of the Botanic Garden, Jena.*

Nov. 1888. Sully, W. C., *Cape Town.*

May 1876. Terracciano, Dr. Nicolao, *Director of the Royal Gardens, Caserta, Campanie.*

June 1902. Tubeuf, Dr. Carl Freiherr von, *Regierungsrath, Münich.*

Nov. 1888. Tyson, W., *Librarian Department of Agriculture, Cape Town.*

June 1902. Wettstein, Dr. Richard, Ritter von Westerheim, *Director of the Seed-Central Nation, Vienna.*

Dec. 1887. Wildpret, H., *Director of the Botanic Garden, Orotava.*

June 1902. Wille, Dr. Johan Nordal Fischer, *Professor in the University, and Director of the Botanic Garden, Christiania.*

Dec. 1870. Willkomm, Dr. Maurice, *Professor of Botany, and Director of Botanic Garden, Prague, Bohemia.*

June 1902. Wood, John Medley, A.L.S., *Curator of the Botanic Garden, Durban, Natal.*

## ASSOCIATES.

Mar. 1886. Bennett, A., F.L.S., 5 *Edridge Road, Croydon.*

Feb. 1876. Campbell, A., 62 *Marchmont Road, Edinburgh.*

Feb. 1871. Evans, William, 38 *Morningside Park, Edinburgh.*

Mar. 1886. Landsborough, Rev. D., *Kilmarnock.*

June 1891. M'Andrew, James, 21 *Gillespie Crescent, Edinburgh.*

Dec. 1883. Richardson, Adam D., 8 *Sciennes Gardens, Edinburgh.*

## LADY MEMBERS.

June 1893. Aitken, Mrs. A. P., 38 *Garscube Terrace, Murrayfield.*

April 1893. Balfour, Mrs. Bayley, *Inverleith House.*

April 1902. Grieve, Mrs. Symington, 11 *Lauder Road.*

Mar. 1904. Maxwell, Mrs., *Bangholm Bower, Goldenacre.*

Jan. 1894. Pearson, Miss C. C., 27 *Royal Terrace.*

June 1893. Sanderson, Mrs. W., *Talbot House, Ferry Road.*

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*Halifax*, . . Department of Agriculture.
Nova Scotian Institute of Natural Science.
*Montreal*, . . Horticultural Society.
*Ottawa*, . . Geological and Natural History Survey of Canada.
Department of Agriculture.
Natural History Society.
*Toronto*, . . Canadian Institute.

#### Costa Rica.

*San José*, . . Instituto Nacional.

#### United States.

*Ames, Iowa*, . Department of Agriculture.
*Auburn, Ala.*, . Department of Agriculture.
*Austin, Texas*, Agricultural Experiment Station.
*Boston, Mass.*, Massachusetts Horticultural Society.
Society of Natural History.
*Cambridge, Mass.*, Harvard University.
*Chicago, Ill.*, . University of Chicago.
*Cincinnati, Iowa*, Society of Natural History.
Lloyd Botanical Library.
*Colorado Springs, Col.* Colorado College.
*Davenport, Iowa*, Academy of Natural Sciences.
*Indianapolis*, . Indian Academy of Sciences.
*Ithaca, N.Y.*, . Cornell University.
*Manhattan, Kansas*, State Agricultural College.
*Minneapolis, Minn.*, Botanical Department, University of Minnesota.
*New Haven, Conn.*, Academy of Arts and Sciences.
*New York*, . . Academy of Sciences.
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*Philadelphia*, . Academy of Natural Sciences.
University of Pennsylvania.
*Rochester, N.Y.*, Rochester Academy of Sciences.
*St. Louis, Missouri*, Botanic Garden.
*Sacramento, Calif.*, University of California.
*San Francisco, Calif.*, California Academy of Sciences.
*Topeka, Kansas*, Academy of Science.
*Trenton, N.J.*, . Natural History Society.
*Washington*, . National Academy of Sciences.
United States Geological Survey.
Smithsonian Institution.

*Washington*, . United States Department of Agriculture :—Bureau of Plant Industry—Division of Agrostology ; Division of Botany ; Division of Entomology ; Division of Forestry ; Division of Microscopy ; Division of Pomology ; Division of Soils ; Division of Vegetable Pathology : National Herbarium : Office of Experiment Stations.

### South America.

*Caracas* . . Junta central del Aclimatacion.
*Monte Video*, . Museo Naçional de Monte Video.
*Rio de Janeiro*, Museo Naçional.

### WEST INDIES.

*Jamaica*, . Botanical Department.
*Trinidad*, . . Royal Botanic Garden.

### AFRICA.

*Cape Colony*, . Botanical Department.
*Durban, Natal*, Botanic Garden.

### ASIA.

*Calcutta*, . . Indian Museum.
Royal Botanic Garden.
*Ceylon*, . . . Royal Botanic Garden, Peradeniya.
*Straits Settlements*, Botanic Gardens and Forest Department.
*Buitenzorg*, . . Botanic Garden.
*Tokio*, . . . Imperial University College of Agriculture.

### AUSTRALASIA.

#### New South Wales.

*Sydney*, . . . Department of Agriculture.
Royal Society of New South Wales.

#### New Zealand.

*Wellington*, New Zealand Institute.

#### Queensland.

*Brisbane*, . . Department of Agriculture.
Royal Society of Queensland.

#### West Australia.

*Perth*, . . . Department of Agriculture.

#### Tasmania.

*Hobart*, . . . Royal Society of Tasmania.

#### Victoria.

*Melbourne*, . . Department of Agriculture.
Royal Society of Victoria.

## EUROPE.

### Austria.

*Cracow*, . . . Academia Umiejetnósci.
*Graz*, . . . Naturwissenschaftlicher Verein für Steiermark.
*Vienna*, . . . Kaiserlich-Königliche zoologisch-botanische Gesellschaft.

### Belgium.

*Antwerp*. . . Vlaamsch nat. en Geneeskundig Congress.
*Brussels*, . . Académie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique.
Institut Botanique, Bruxelles.
Société Royale de Botanique de Belgique.
*Liége*, . . . Botanic Garden.

### Denmark.

*Copenhagen*, . Botaniske Forening.

### France.

*Amiens*. . . . Société Linnéenne du Nord de la France.
*Cherbourg*. . . Société Nationale des Sciences Naturelles et Mathematiques.
*Lille*. . . . Institut Colonial de Marseille.
*Lyons*, . . . Société Botanique.
*Marseille*. . . Faculté des Sciences de Marseille.
*Paris*, . . . Société Botanique de France.
*Toulouse*, . . Société Française de Botanique.

### Germany.

*Berlin*. . . . Botanischer Verein für die Provinz Brandenburg und die angrenzenden Länder.
*Bonn*, . . . Naturhistorischer Verein der preussischen Rheinlande, Westfalens, und der Regierung-Bezirks Osnabruck.
Niederrheinische Gesellschaft für Natur-und Heilkunde.
*Braunschweig*, . Verein für Naturwissenschaft.
*Bremen*, . . . Naturwissenschaftlicher Verein.
*Breslau*, . . . Schlesische Gesellschaft für vaterlandische Cultur.
*Erlangen*, . . Physikalisch-medicinische Societät.
*Frankfort-am-Oder*, Naturwissenschaftlicher Verein des Regierungsbezirks.
*Giessen* . . . Oberhessische Gesellschaft für Natur- und Heilkunde.
*Halle*, . . . Kaiserliche leopoldino-carolinische deutsche Akademie der Naturforscher.
*Hamburg*, . . Botanische Staatsinstitute.
*Heidelberg*. . Deutsch ostafrikanische Gesellschaft.
*Kiel*, . . . Naturwissenschaftlicher Verein für Schleswig-Holstein.
*Königsberg* . Physikalisch-oekonomische Gesellschaft.
*Munich*. . . . Baierische Gesellschaft.
*Stuttgart*, . . Verein für Vaterlandische Naturkunde.

### Great Britain and Ireland.

*Alnwick*. . Berwickshire Naturalists' Club.
*Belfast*, . . . Natural History and Philosophical Society.
*Bristol*, . . . Bristol Naturalists' Society.
*Buckhurst Hill*, Essex Field Club.

| | |
|---|---|
| *Dublin*, . . . | Royal Dublin Society. |
| *Edinburgh*, . . | Royal Scottish Arboricultural Society. |
| | Royal College of Physicians. |
| | Edinburgh Geological Society. |
| | Royal Society of Edinburgh. |
| | Royal Physical Society. |
| | Royal Scottish Geographical Society. |
| | Royal Scottish Society of Arts. |
| | University of Edinburgh. |
| *Glasgow*, . . | Natural History Society. |
| | Royal Philosophical Society. |
| | University of Glasgow. |
| *Leeds*, . . . | Yorkshire Naturalists' Union. |
| *Liverpool*, . . | Literary and Philosophical Society. |
| *London*, . . . | Board of Agriculture. |
| | Editor of *Gardeners' Chronicle*. |
| | Linnean Society. |
| | Editor of *Nature*. |
| | Pharmaceutical Society of Great Britain. |
| | Quekett Microscopical Club. |
| | Royal Gardens, Kew. |
| | The Royal Society. |
| | Royal Horticultural Society. |
| | Royal Microscopical Society. |
| *Manchester*. . | Manchester Literary and Philosophical Society. |
| *Durham*, . . | College of Science. |
| *Newcastle-upon-Tyne*, | Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, and the Tyneside Naturalists' Field Club. |
| *Norwich*. . . | Norfolk and Norwich Naturalists' Society. |
| *Perth*, . . . | Perthshire Society of Natural Science. |
| *Plymouth*, . . | Plymouth Institution. |
| *Watford*, . . | Hertfordshire Natural History Society and Field Club. |

### Holland.

| | |
|---|---|
| *Amsterdam*. . | Koninklijke Akademie van Wettenschappen. |
| *Haarlem*, . . | Koloniaal Museum. |
| | Musée Teyler. |
| | Nederlandische Maatschappij ter Bevordering van Nijverheid. |
| *Luxembourg*, . | Société Botanique du Grand-duché de Luxembourg. |

### Italy.

| | |
|---|---|
| *Florence*, . . | Soc. Botanico Italiano. |
| *Rome*, . . . | Reale Instituto Botanico. |

### Portugal.

| | |
|---|---|
| *Lisbon*, . . . | Academia real das Sciencies. |
| | Editor of *Broteria*. |

### Roumania.

| | |
|---|---|
| *Bucharest*. . . | Institut Botanique. |

### Russia.

| | |
|---|---|
| *Helsingfors*, . | Societas pro Fauna et Flora Fennica. |
| *Kieff*, . . . | Société des Naturalistes. |
| *Moscow*, . . | Société impériale des Naturalistes. |
| *St. Petersburg*, | Hortus botanicus imperialis. |

SCANDINAVIA.

| | |
|---|---|
| *Christiania.* | . Nyt Magazin. |
| *Lund,* . . | . Universitas Lundensis. |
| *Stockholm.* . | . Kongl. Svenska Vetenskaps Akademien. |
| | Sveriges Offentliga Bibliotek. |
| *Upsala.* . . | . Societas Regia Scientiarum. |

SWITZERLAND.

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|---|---|
| *Basel,* . . | . Schweizerischer Botanischer Gesellschaft. |
| *Berne,* | . Naturforschende Gesellschaft |
| *Geneva* . | . Herbier Boissier. |
| *Zurich.* . . | . Naturforschende Gesellschaft. |

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